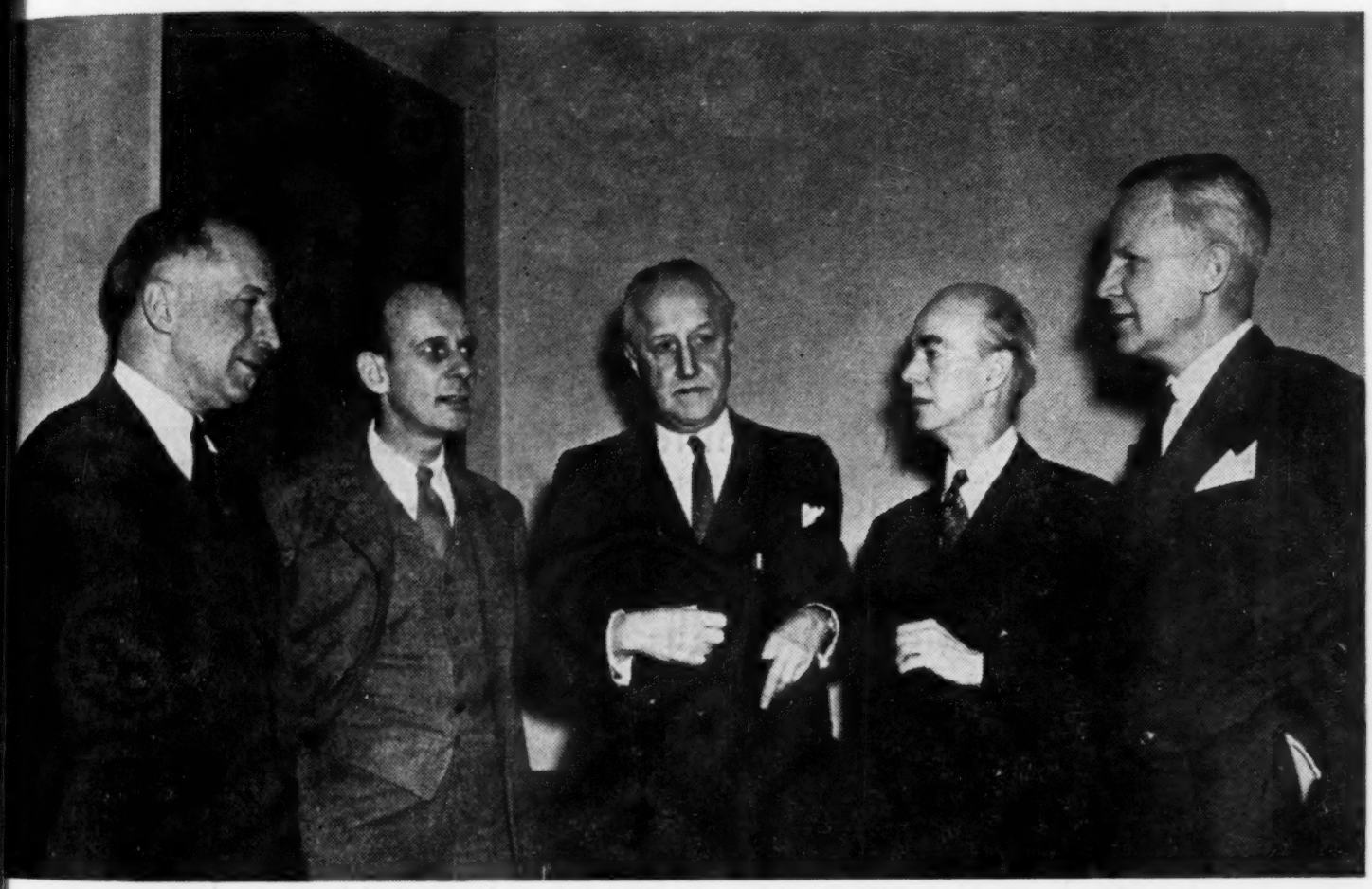
Vol. 105
No. 2726

Pages 323-346

March 28, 1947

Science

THE SCIENTISTS NEWSWEEKLY



A group of principals present at the award of the Whittlesey House-*Science Illustrated* $10,000 prize to Clyde Kluckhohn for his manuscript, *Anthropology and the world today.* Left to right: Gerald Wendt, managing editor, *Science Illustrated,* who was chairman of the Judging Committee; Clyde Kluckhohn, who won the prize; Waldemar Kaempffert, who served on the Judging Committee; John O'Neill, science editor, *New York Herald Tribune*; and Paul Montgomery, publisher, *Science Illustrated* (see *News and Notes*).

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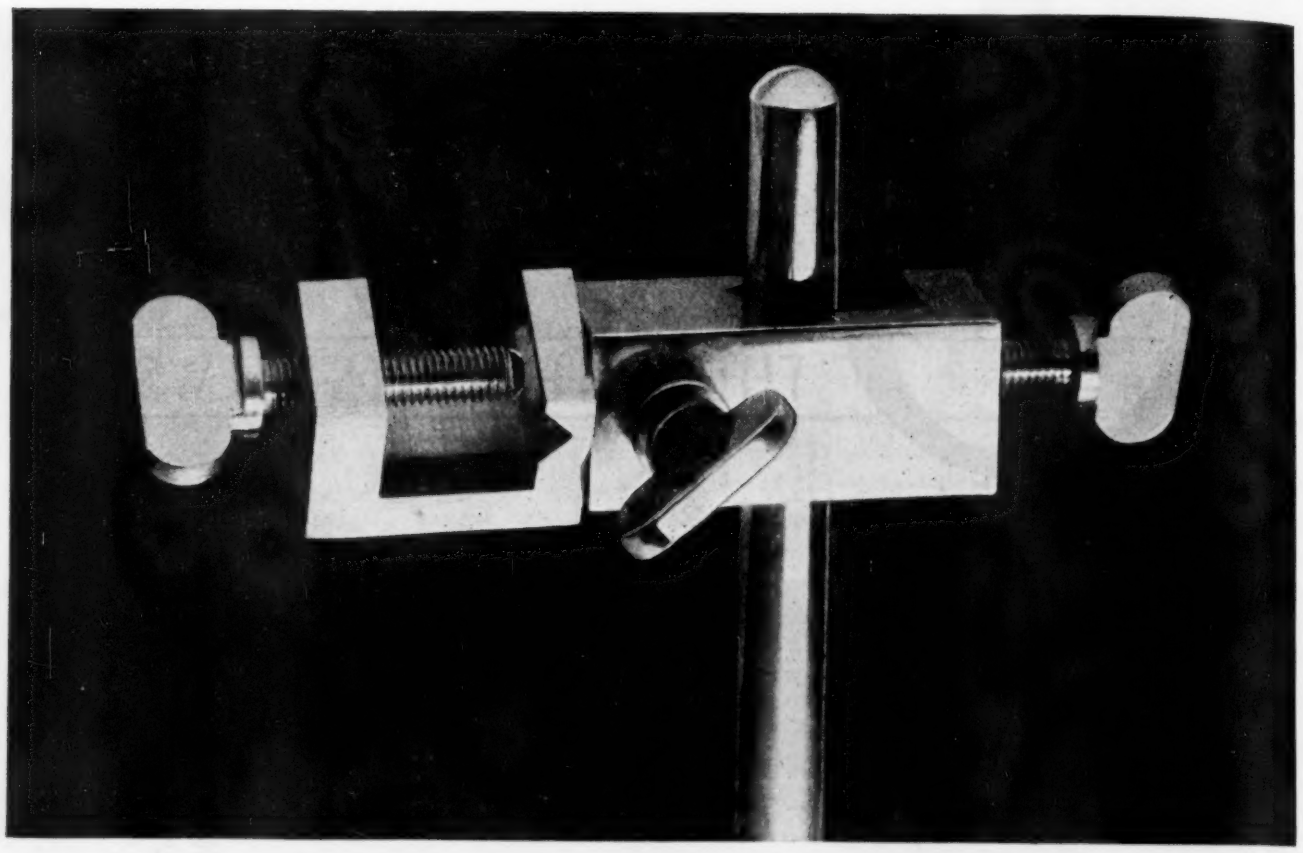
Cosmic Radiation and Cancer

Frank H. J. Figge

A SWIVEL THAT HOLDS



Swivel Clamp—One-tenth enlarged

Accurately machined from brass and durably nickeled. The swivel-joint is fixed by an adjusting screw bearing internally upon a frictional device which requires only slight tension for a secure grip.

The cut is slightly enlarged to match the diameters of the new *Heavy Clamp*, which is without swivel but with knurled heads and with jaws of $\frac{3}{4}$-inch capacity. Material and finish are the same for both clamps.

Write for the current price-list of physiological apparatus.

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Dover, Massachusetts

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Science

Vol. 105 No. 2726 Friday, March 28, 1947

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Science, a weekly journal, is published each Friday by the American Association for the Advancement of Science at Mt. Royal & Guilford Avenues, Baltimore 2, Maryland. Founded in 1880, it has been since 1900 the official publication of the AAAS. Editorial, Advertising, and Circulation Offices, 1515 Massachusetts Avenue, N.W., Washington 5, D. C. Telephone, EXecutive 6060 or 6061. Cable address, SCIMAG.

Articles offered for publication should be sent to the Editor, 1515 Massachusetts Avenue, N.W., Washington, 5 D. C.

Membership correspondence for the AAAS should be sent to the Administrative Secretary, 1515 Massachusetts Avenue, N.W., Washington 5, D. C.

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Entered as second-class matter January 17, 1947, at the postoffice at Baltimore, Maryland, under the act of March 3, 1879.

Cosmic Radiation and Cancer

Frank H. J. Figge
University of Maryland Medical School, Baltimore

THE FACT THAT THE TOTAL ENERGY received by the earth as cosmic radiation is no greater than that of starlight has led many to assume that this could have little, if any, biological effect. Other considerations would indicate, however, that even radiation of such low intensity may have an influence on so-called spontaneous mutations and genetic effects in general. One must admit that these effects may occur with any amount of radiation, and even though the probability decreases with lower intensities, it must be remembered that all living things receive a continuous exposure throughout life. The term "lifetime exposure" is somewhat indefinite in this instance, since protoplasm is passed from one generation to another, and the biological effects of such low-intensity radiation may be additive over a period of several generations.

The theoretical speculations which have emphasized the low intensity and ignored or minimized the possibility of biological effects have probably served only to inhibit the search for such effects. There appears to be a need for less speculation and more experimental testing. This is especially true in the field of cancer research for, in spite of the attractive nature of such investigations, the writer was unable to find a single reference involving the experimental evaluation of the possible influence of cosmic radiation on carcinogenesis. The technical difficulties involved in evaluating such an omnipresent factor may also have had a deterrent influence, for in order to obtain conclusive data on the influence which cosmic radiation may have in regulating cancer incidence, it would be necessary to study the induction of cancer with various agents in an environment free from cosmic radiation. This would require a chamber with lead roof at least 49 feet thick or laboratory space 700 feet underground. Since the former was regarded as impractical and the latter was impossible with the funds available, a simple substitute procedure was devised.

It was hoped that the results of this preliminary experiment would indicate whether it would be worth while to investigate this problem more extensively. The experiment[1] involved the attempt to intensify cosmic radiation effects by means of various combinations of lead plates and the comparison of the rate of carcinogenesis in mice receiving the intensified cosmic radiation with the rate of carcinogenesis in mice receiving non-intensified (normal) cosmic radiation. The rate of induction of cancer in the mice kept under the lead plates was found to be consistently and definitely higher than that in the controls.

One hundred and eighty-four male mice[2] of the C_3H strain were injected with 0.25 mg. of methylcholanthrene in sesame oil and distributed equally in 8 aluminum cages, 11 x 11 x 4 inches. They were given food and water ad libitum.

Lead plates ¼ inch thick were placed over 5 of the 8 cages. Lead of this thickness was chosen because it had been shown by other investigators (*3*) that the optimum thickness for the production of small cosmic radiation showers was 0.6 cm. while the optimum thickness for the production of large showers was approximately 2 cm. Four of the cages were, therefore, covered with only one sheet of lead while two lead sheets were placed over the fifth. Cage 1, without a lead plate, and Cage 2, with one lead plate, were placed on the top shelf of a metal rack on the fifth floor of a six-story concrete steel building. Cages 3 and 4, a similar pair, were placed on the top shelf of a metal rack on the first floor of the same building. Cages 5 and 6, with one lead plate on each, were arranged on the second and third shelves from the top of the rack vertically below Cage 4. Cage 7, with two lead-plate covers, was placed vertically below Cages 4, 5, and 6. Cage 8, without a lead cover, was placed 4 inches south of Cage 7 and vertically below Cage 3. Cage 8, although not vertically below Cages 4 and 5, was near enough to have received some scattered cosmic ray showers from the lead plates over the latter cages. It was also beneath three iron shelves of the rack. No data could be found on cosmic ray showers in iron, but these probably would occur. Both of these unanticipated circumstances would, theoretically, have had a tendency to increase the intensity of cosmic radiation in control Cage 8 as compared to that in the other two control cages (1 and 3), which were on the top shelves. The metal shelves were painted on each side of the cages so that the position of the cages was maintained relatively constant throughout the 5-month period of observation.

The results were tabulated (see Table 1) using the method of Shimkin and Andervont (*2*). It will be noted that 5 cages contained one or two mice less than 23. In these instances, the mice died or disappeared before the eighth week and were not included in the tabulation. The mice in the three control cages without lead plates

[1] This work was supported by grants from the Anna Fuller Fund and the Donner Foundation.

[2] These mice were progeny of mice obtained from L. C. Strong, of New Haven, Connecticut, several years ago.

are placed together in the table. The numbers in vertical columns below the time in weeks represent the number of new tumors found at each weekly examination. It is apparent that the tumors in the controls developed at a slower rate than in the mice covered with lead plates. It may also be noted that in the lead-plate-covered cages a relatively large number of tumors was recorded on the earliest week tabulated. With a dose of 0.25 mg. of methylcholanthrene, one would expect the first tumor to appear at the seventh or eighth week. It is, therefore, unfortunate that the weekly examinations were not started at an earlier date, because it seems probable that some of the tumors listed under the sixth week may have been palpable earlier. Even with this handicap, the average latent period for the lead-plate-covered mice was only 8.5 weeks as compared with 11.3 weeks for the controls. The 50 per cent latent period—the average latent period for the first 50 per cent of the animals to develop tumors—was 9.6 for the controls and 6.7 weeks for the lead-plate-covered mice.

In experiments of this kind, where practically all the animals eventually develop tumors, one is not concerned with the percentage of animals developing tumors but primarily with the rate of tumor development as expressed in average latent periods.

Only 2 of the 67 controls and 1 of the 111 lead-covered mice did not develop tumors within the period of 22 weeks. These mice had to be excluded from data on the average latent period calculations. However, the carcinogenic index, derived from a formula suggested by Iball (*1*), takes these animals into account. Iball's formula is $\frac{p}{t} \times 100$, where p is the per cent of mice developing tumors and t is the average latent period of the whole group in days. Higher numbers thus indicate more potent carcinogenic stimuli. The index for the control group was 123, while for the lead-plate-covered animals it was 168.

None of these calculations or sets of numbers appears to do justice to the acceleration of the rate of tumor formation which was observed in the early part of the experiment. The remarkable difference between controls and experimental animals which was apparent early in the experiment is indicated by the total number of mice with tumors in each cage at the end of 10 weeks. Control Cage 8 contained 10 mice with tumors at this time. The lowest number of tumors in any of the lead-plate-covered cages was 14. Cage 8, however, was the control cage beneath three metal shelves and may have received scattered cosmic radiation showers from the lead over Cages 4 and 5. Even with the inclusion of this cage in the calculations at the end of 10 weeks, only 22 or 33 per cent of the 66 control mice had developed tumors while 75 per cent of the 110 lead-covered mice had developed tumors which grew progressively larger.

It was of interest that the highest percentage of tumors occurred in Cage 7, which was covered with two lead plates instead of one and placed beneath three iron shelves and three other cages with lead-plate covers. Twenty-one of the 23, or 91 per cent, of the mice in this cage had developed tumors within 10 weeks. The thickness of lead directly over this cage was near the optimum for the production of larger cosmic ray showers. However, the total thickness of lead above the cage (5 cm.) was greater than the optimum. The cages had been arranged in this way in the hope of detecting a possible protective effect due to absorption, but, obviously, such an effect was not observed.

This remarkable increase in the rate of tumor induction brought about by placing lead plates 3 inches above methylcholanthrene-injected mice was thought to

TABLE 1

INFLUENCE OF LEAD-PLATE CAGE COVERS (INCREASED COSMIC RADIATION INTENSITY) ON RATE OF INDUCTION OF PALPABLE SUBCUTANEOUS TUMORS IN C_3H MALE MICE INJECTED WITH 0.25 MG. 20-METHYLCHOLANTHRENE

Cage	Lead plate	No. of mice	No. of tumors per week and time (wks.)																Non-tumor	No. tumors	Avg. latent period (wks.)	50% latent period	Carcinogenic index	Tumors (10 wks.)
			6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21						
1	0	22			1	1	2	6	6	2	3	1							0	22	11.7	10.5	123	4
3	0	22		1	3	1	2	1	5	2	4							1	2	20	11.7	9.5	111	8
8	0	23		1	4	1	4	5	5	2	1								0	23	10.6	9.	135	10
Total.....		67		2	8	3	8	12	16	6	8	1						1	2	65	11.3	9.6	123	22
2	1	22	7	4	3	2	2	3		1									0	22	8.1	6.4	177	18
4	1	22	4	4	2	2	2	2	3	2						1			0	22	9.5	7.	151	14
5	1	21	1	6	6	0	1	4	2	1									0	21	8.9	7.3	161	14
6	1	23	6	4	4	1	2	4	1	1									0	23	8.4	6.5	166	17
7	2	23	6	5	8	1	1	1											1	22	7.5	6.5	181	21
Total.....		111	24	23	23	6	8	14	6	5						1			1	110	8.5	6.7	168	84

be related to the intensification of the cosmic radiation which results from the production of showers or bursts of ionizing radiations which occur when cosmic rays pass through thin sheets of metal. According to this hypothesis, carcinogenic substances such as methylcholanthrene induce cancer by converting some of the energy of cosmic radiation into carcinogenic stimuli; in other words, they sensitize the tissues to this kind of energy. It should be emphasized, however, that these experiments are only preliminary and that conclusive data can be derived only from experiments carried out in the absence of cosmic and other types of radiation.

If this general hypothesis continues to receive verification in future experiments, we may then begin to speculate on how to reduce the incidence of cancer by minimizing the effect of such radiation. The first reaction to such an hypothesis is that, if true, it would be futile to attempt to prevent cancer, because cosmic radiation cannot be avoided. In the first place, it may not be impossible to minimize the life exposure of such radiations by regulating building materials and other environmental factors which may modify the effective intensity of such radiation. Secondly, it has not been the intention of the writer to give the impression that cosmic radiation is the only factor involved in carcinogenesis. Other factors, such as the heavy metals and chemicals within tissues that absorb and modify such radiation, may thus offer possibilities for nullifying the effect of such radiations. Further, the radiation sensitivities of cells of the same and different individuals must vary within wide limits. It is possible that the variation in this respect controls the age at which cancer develops. As the life expectancy of a population increases, more and more people survive long enough to have their least resistant cells undergo malignant transformation as a result of the cumulative and additive effect of cosmic and other similar radiations. In addition to the increased length of the exposure time, we may be increasing the intensity factor by spending a high proportion of our life in buildings beneath roofs and other materials which serve to produce cosmic radiation showers and thus intensify the radiation effects. According to the results of this experiment, an individual whose least resistant cells could stand 50 years of unaltered radiation would conceivably develop cancer at 40 years or earlier if most of the lifetime had been spent in a building which served to intensify cosmic radiation. There are doubtless many other factors that would offer avenues of attack and investigation.

It is most important at present, however, to test this hypothesis further in a conclusive way by repeating these experiments in an environment free from cosmic radiation. Plans to do this are in progress. The prospect of a general exposure of large numbers of people to radiations of this type as a result of developments in the atomic energy field and the consequent popularization of the use of radioactive material provides an added incentive for hastening the investigation. It would seem in order to re-examine qualitatively and quantitatively the question of what is a safe dose of radiation. This should be determined not only for what we call normal cells but also for the occasional extremely radiation-sensitive cell and on the basis of a lifetime exposure.

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Does Patent Consciousness Interfere With Cooperation Between Industrial and University Research Laboratories?

L. A. Hawkins, *Consultant, Research Laboratory, General Electric Company, Schenectady, New York*

ALTHOUGH OUR PATENT SYSTEM IS among the older of our national institutions, there still appear to be misunderstandings concerning it which are not confined to the less educated portion of our public.

A recent meeting of scientists brought forth an implied criticism of our patent system in the statement, which seemed to meet acceptance with many, that overconcern for patents caused many industrialists to draw an iron curtain around their research laboratories, thereby excluding from their research staffs the visits of other scientists and preventing the mutually helpful interchange of information and the stimulating exchange of ideas which are vital to the rapid progress of scientific knowledge.

In every occupation of mankind there are shortsighted individuals, and there may be some industrialists who would prefer to confine their research men in an ivory tower, but it is strange that such a policy should be blamed on the very institution which makes such a policy needless and foolish.

If we had no patent system, then indeed it would be necessary for an industrialist, if he had a research laboratory, to make the hard choice between free scientific exchange, with the practical certainty of frequent and immediate financial loss, and scientific isolation, with the long-range certainty of ultimate sterility. Or perhaps he might attempt a compromise, with the probability of incurring both kinds of loss. Under such conditions, probably very few companies would start or long maintain a research laboratory. It would need a farsighted, courageous, and patriotic industrialist with a long pocketbook to undertake research under such conditions. Such a man, fully realizing that in the long run industrial progress is dependent on scientific research, and that, if there were no industrial research in this country, his whole industry and his company along with it would suffer mortally from competition of other countries where industrial research conditions were more favorable, would decide that he must support some research, even in the face of certain immediate loss in domestic competition.

Our patent system obviates the necessity for such hard decisions. It makes it possible to operate a research laboratory with doors wide open to the stimulating visits of outside scientists, without loss and with the great benefit of the mutual fertilization of ideas which such visits produce.

Patenting an invention protects the inventor or his employer from the gratuitous pirating of its benefits by others. If others wish to share in those benefits they may be made to share in its cost, through reasonable royalty payments. The effect on the research man in industry is that he is free to welcome fellow scientists from universities or other industrial laboratories, exchange information with them, discuss experiments, compare ideas, and argue on theoretical matters.

The prime function of a research laboratory is to seek new scientific facts. A newly-discovered fact may suggest a patentable application or new material, but the invention is incidental to the scientific work which claims the research man's main interest and which is not patentable. If there were no patent system, not even that scientific work could be freely discussed with fellow scientists for their mere presence in the laboratory would involve possible loss, through their observing and disclosing, quite possibly in all innocence, to its competitors practical developments in progress in the laboratory. Without a patent system, the only safeguard for discovery and its practical applications would be complete secrecy. Furthermore, no industrial research laboratory could safely welcome visitors or send its men to meetings of scientific societies except in the role of sponges, permitted only to absorb in silence.

With our patent system the industrial scientist may enjoy all the freedom to give and take which is possessed by his peers in the universities. The only restraint on his tongue or pen is that, if his work suggests a possible patentable practical application, his first disclosure should be to his patent attorney; and, if the latter thinks a patent application advisable, reasonable time should be given to prepare the necessary papers before further disclosure is made. If he observes this trifling and temporary restraint, the industrial scientist may enjoy to the full his intercourse with his fellows, free and unconstrained, and the institution he serves may reap the undoubted benefit such intercourse yields.

A few industrialists and possibly a very few directors of research may not even yet be fully awake to the opportunity of free scientific exchange in safety which our patent system makes possible. The increasing frequency of exchange of visits between industrial laboratories, as well as between these and the universities, shows that the number of those who have not yet seen the light is small and is growing smaller. As concerns those few, to blame the patent system rather than their

ndividual blindness for their shortsighted policy is urely an error.

No human institution is perfect, and our patent system a human institution. Indeed the advisory committee ppointed by President Roosevelt has recommended ertain minor changes in it, which informed opinion quite enerally believes might be adopted with advantage y Congress, but the basic principles of that system he committee found to be sound.

Their finding seems supported by the record. With hat system in force, our Nation has achieved the greatest ertility in invention and the greatest industrial progress he world has yet seen. Many a small manufacturer, rotected by his patent, has built up a highly prosperous business with some meritorious specialty. Manufacturers large and small, to the number of over 2,500, relying on the patent protection they could obtain for applications of research, have founded and are profitably operating research laboratories and thereby helping in the advancement of their industries, the national economy, and scientific knowledge. As for the scientist himself, if he wishes to take advantage of the facilities offered by an industrial laboratory for research in his special field of interest and if he finds that he may do so with no sacrifice of his precious privilege of free discussion with his fellow scientists, whatever their associations may be, he should give thanks where thanks are due—to our patent system.

Theory of Reactions of Cells to Goitrogenic Thiopyrimidines

Louis Laufer and Earl D. Stewart

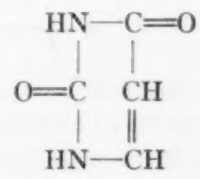
Schwarz Laboratories, Inc., New York City

CERTAIN SULFANILAMIDES, as well as thiourea and its derivatives, have been found by Astwood (*1*) to be effective in the treatment of hyperthyroidism. One of the most potent of these derivatives is thiouracil (II). Clinical tests (*7*) on more than 1,000 patients have proved its curative value. In about 10 per cent of the patients, however, toxic reactions such as skin rashes, urticaria, fever, agranulocytosis, and leukopenia occur in the first five weeks of treatment and, as a result, a number of deaths due to the administration of thiouracil have been reported. Thiothymine (IV), or 5-methyl thiouracil, has also been tested (*10*) on rats and clinically, and found to be less effective than thiouracil in cases of thyrotoxicosis.

Reports by Astwood (*2*) and by Leys (*4*) have shown that alkyl substitution in the 6-position of the pyrimidine yields products which are as active, or more active, than thiouracil without any toxic reactions appearing in clinical tests. Thus, 6-normal propyl thiouracil (VI) (*2*) is about 11 times as active as thiouracil. Miller, *et al.* (*6*) showed that thiopyrimidines react with several equivalents of iodine, supporting the hypothesis that these compounds may prevent thyroid hormone synthesis in the gland by blocking the iodination of hormone precursors. They also state that these compounds may decrease iodine liberation by action on the appropriate oxidative enzymes and suggest this also as an explanation for the antithyroid action of the sulfa drugs.

We would like to go somewhat further in explaining the action of the mercaptopyrimidines, basing the explanation on the available evidence. We would postulate that thiouracil and thiothymine, in addition to reacting with iodine, act as antivitamins or antibiotics. The term "antibiotic" is used here somewhat more generally than may be customary, for lack of a better way of expressing the effect of any agent whose presence interferes with or prevents normal cell proliferation *in vivo*. The cells may be those of microorganisms foreign or injurious to the host, or cells of the body tissues or circulatory system of the host proper.

Snell and Mitchell (*8*) have proved uracil to be an essential metabolite for the growth of microorganisms, very strongly suggesting vitamin action. Similarly, thymine (*9*) can partially replace folic acid as an essential nutrilite for lactic acid bacteria. The structural similarities of uracil (I) and thiouracil (II) and of thymine (III) and thiothymine (IV) are shown below.



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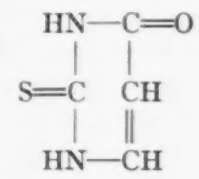

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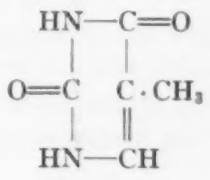

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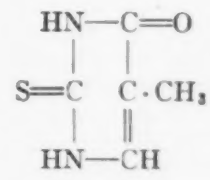


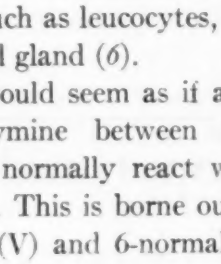
(IV)

The conversion of a vitamin or an essential nutrilite

to an antivitamin or antibiotic by alteration of the chemical structure of the vitamins has been demonstrated by Woods (*11*) for para-aminobenzoic acid and sulfanilamide; by Woolley and White (*12*) for 2-methyl-4-amino-5-pyrimidylmethyl-(2-methyl-3-hydroxyethyl) pyridium bromide and vitamin B_1; and by McIlwain (*5*) for pyridine-3-sulfonic acid and nicotinic acid.

The toxic reactions of thiouracil and thiothymine *in vivo*, especially the incidence of agranulocytosis and leukopenia, bear a marked resemblance in this respect to the toxic action of sulfanilamide, another antivitamin (*11*). Apparently, with some individuals these drugs interfere with the normal metabolism of certain body cells such as leucocytes, and even those occurring in the thyroid gland (*6*).

It would seem as if a competition for thiouracil and thiothymine between iodine and other compounds which normally react with uracil and thymine occurs *in vivo*. This is borne out by the fact that 6-ethyl thiouracil (V) and 6-normal propyl thiouracil (VI) (*2*) are



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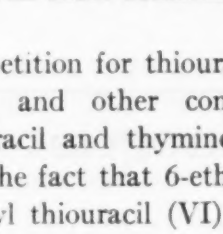
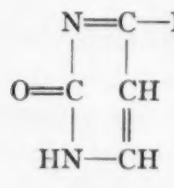


(VI)

8 and 11 times more effective, respectively, than equivalent amounts of thiouracil and exhibit no toxic reactions when tested clinically. Evidently these two mercaptopyrimidines have had their chemical structure sufficiently altered to react wholly with iodine, hence showing only a goitrogenic action and no antibiotic tendency.

It is of interest to note that uracil occurs only in ribonucleic acid and thymine only in thymus nucleic acid. Both nucleic acids occur in normal cells; thymus nucleic acid, only in cell nuclei; ribonucleic acid, in both nucleus and cytoplasm. A pyrimidine which occurs in both nucleic acids is cytosine. It might be predicted, therefore, that while thiocytosine (VIII), structurally analogous to cytosine (VII), would exhibit antithyroi



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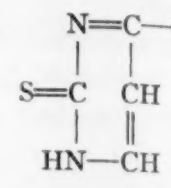

(VIII)

action, it might also be more toxic or show greate antivitamin action than either thiouracil or thiothymine because structurally it is analogous to cytosine, a buildin block in not only one but two fundamental cell com ponents.

While these mercaptopyrimidines have been teste *in vivo*, no study has been made to assess their value a antivitamins with microorganisms. Hitchings, *et al* (*3*) report one test at low concentration on the effect o thiothymine on *L. casei* with inconclusive results.

A thorough study of the action of thiouracil, thiothymine, and especially thiocytosine on a variety o microorganisms including pathogenic forms might be o interest not only to see if antivitamin or antibiotic activity is a characteristic of these sulfur-bearing pyrimidines, but also to obtain evidence of the importance o the normal oxycompounds to cell metabolism. Such a study might also reveal in mercaptopyrimidines and their homologues and derivatives a new class of compounds with antiseptic properties for external use.

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Section E (Geology and Geography) is planning to schedule sessions at the Chicago meeting of the AAAS, on Friday and Saturday, December 26 and 27. Several special sessions are now in the planning stage. Any suggestions concerning the section program should be sent to G. W. White, secretary, Section E, Orton Hall, Ohio State University, Columbus 10, Ohio. Titles of papers offered for presentation at the meeting should be sent to the secretary by May 1, except for papers now being arranged by the various symposium organizers.

NEWS
and Notes

During the week past the Inter-Society Committee for a National Science Foundation announced the results of a survey of the representatives of the 70-odd scientific and educational organizations that constitute the members. Questions were directed to four of the controversial issues: type of administration, inclusion of the social sciences, inclusion of undergraduate fellowships, and patent provisions. The fifth controversy over the mandatory geographical distribution of funds was not included in the questionnaire.

Two-thirds of the respondents favored a single administrator; 18 per cent favored a Foundation made up of a large number of people; and 18 per cent favored the commission type of administration.

Ninety-eight per cent of the respondents favored the inclusion of the social sciences, either by specific mention or by the permissive provisions of S. 526 and the corresponding House bills. A large majority believed that undergraduate scholarships should be granted, 86 per cent voting in favor of this provision. Ninety-four per cent of the respondents believed that no special stand should be taken on patent legislation.

Certain other questions were designed to find out what compromise, if any, would be acceptable to scientists. The vote was:

Willing to accept a Commission if necessary, 95 per cent.

Willing to accept a single Administrator if necessary, 88 per cent.

Willing to accept a 48-man Foundation if necessary, 86 per cent.

Willing to accept permissive inclusion of social sciences, 99 per cent.

Willing to accept specific inclusion of social sciences, 94 per cent.

Willing to accept exclusion of social sciences, 37 per cent.

These percentages are based on a return of 73 per cent.

It would appear that the opinion of American scientists with regard to the best bills establishing a National Science Foundation would be made up of a combination of those now before the Congress. The language of S. 526 in connection with the inclusion of the social sciences, the provision for undergraduate fellowships, and the patent provisions would seem to be satisfactory, while the single administrator provided in S. 525 is preferred.

Clyde Kluckhohn, Department of Anthropology, Harvard University, has been awarded the $10,000 prize in the Whittlesey House-*Science Illustrated* Contest to encourage publication of scientific books for general readers. Dr. Kluckhohn's book, *Anthropology and the world today*, will be published during the coming year, as will five other books put under contract as a result of the contest. These five contestants will receive $1,000 each as an advance against standard royalties in order that they may complete their projects.

Manuscripts did not have to be complete to be entered in the contest, which closed November 1, 1946. An outline and 10,000 words were required at that time, and the completed book, ranging in length from 80,000 to 150,000 words, must be finished not later than November 1, 1947. More than 250 outlines and sample chapters were submitted.

The purpose of the prize-winning book, *Anthropology and the world today*, is to make plain the varying goals and interrelations of the branches of anthropology and demonstrate how anthropology has been useful in practical ways.

Following are additional books receiving honorable mention:

Men out of Asia, by Harold S. Gladwin, a discussion of the origin of the American Indian in which the author argues for migration from a common Asiatic source via previously existing land bridges, as against the view of independent evolution.

You and your doctor, by Benjamin F. Miller, which attempts to acquaint the layman with the problems of the general practitioner.

Mendelyeev, by Daniel Q. Posin, a biography of the formulator of the Periodic Table in chemistry and an outstanding Russian scientist of the 19th Century.

Whom the gods love, by Leopold Infeld, a biography of Evariste Galois, extraordinary child mathematician.

Causes of catastrophe, by L. Don Leet, which tells cause and effect of forces that shake the earth's crust with explanations of the geological processes involved.

Judges of the contest were Harlow Shapley, director of the Harvard College Observatory and president of AAAS; Waldemar Kaempffert, science editor, *New York Times*; Donald Culross Peattie, naturalist; and Gerald Wendt, managing editor, *Science Illustrated*.

Whittlesey House and *Science Illustrated* are member organizations of McGraw-Hill Book Company, Inc., whose president, Curtis Benjamin, made the awards on March 14. Mr. Benjamin also announced that Dr. Kluckhohn had made a gift of $2,500 from his prize to Harvard University for research on the Navaho.

In a letter to President Truman, dated March 24, the Federation of American Scientists has urged that none of the Germany military scientists imported by the Army be given civilian employment or other privileges, and that they be returned to Germany as soon as possible.

W. A. Higinbotham, executive secretary of the Federation, stated that an inquiry to the War Department had brought a reply that, so far as citizenship is concerned, the German scientists will "in general" be subject to the usual immigration regulations. He added that a State Department spokesman had assured him that the war scientists are here as aliens in military custody, and will have to leave this country and apply for citizenship through the usual quota channels if they wish to be naturalized.

The full text of the statement by the Federation of American Scientists follows:

Dear Mr. President:

In press releases on September 13 and December 4, 1946, the War Department announced that, for the past year, it had been bringing into the United States key German scientists to act as consultants to various military research projects. The releases indicated that this program is to be extended, and that plans exist whereby some former enemy technical personnel will be permitted to accept positions in private industry and educational institutions upon completion of their present assignments. The possibility also was mentioned that the privilege of citizen-

ship might be extended to certain of these individuals.

The Federation of American Scientists wishes to express to you its deep concern over the implications of this War Department program. Certainly not wishing to jeopardize the legitimate needs of national defense, and not advocating a policy of hatred and vengeance toward our former enemies, we nevertheless believe that, during this critical post-war period of national and international adjustment, wholesale importation of scientists is not in keeping with the best objectives of American domestic and foreign policy. We believe that the high positions of trust and responsibility occupied by these individuals in the Third Reich demonstrate that they were either sympathetic with Nazi aims or, at the very least, acquiescent in them.

Any favor extended to such individuals, even for military reasons, represents an affront to the people of all countries who so recently fought beside us, to the refugees whose lives were shattered by Nazism, to our unfortunate scientific colleagues of formerly occupied lands, and to all of those others who suffered under the yoke these men helped to forge. It is not fitting that those who abetted tyranny should find a haven in free America to which the victims may not attain, that we should accept former enemies while barring those who were, and are our allies.

We therefore respectfully urge that the use of Nazi scientists by the armed forces be held to an absolute minimum, that none of them be granted citizenship, that none of them be given employment in industrial or academic installations, and that all of them be sent back to Germany as soon as possible.

Visitors to U.S.

H. B. G. Casimir, co-director of the Philips Research Laboratories, Eindhoven, Holland, arrived in the United States this month to deliver a series of invitation lectures at Johns Hopkins University, Baltimore, on properties of matter at low temperatures and on problems in quantum electrodynamics. Dr. Casimir, who joined the staff of Philips Research Laboratories in 1942, has been directing the assembly of a cyclotron at an independent laboratory in Amsterdam by Philips in cooperation with the Dutch Government.

Corneille Heymans, professor of pharmacology, University of Ghent, Belgium, will spend May and June in the United States as guest of the American Medical Association. Dr. Heymans, Nobel Prize winner, will attend the AMA centennial meeting in Atlantic City and the meetings of the Federation of American Societies for Experimental Biology in Chicago in May.

Grants and Awards

Syracuse University College of Applied Science, Syracuse, New York, has been awarded $46,000 in government contracts for industrial research. The Syracuse study, under Ralph E. Montonna, director of the College's Institute of Industrial Research, and B. J. Lazan, chief of the Materials Testing Laboratory, will follow two paths. A study of temperature-resistant materials is being sponsored by the AAF with a grant of $27,000, and the Office of Naval Research has allocated $19,000 for testing the abilities of materials and structures to absorb vibrational energy.

The Cyrus M. Warren Fund of the American Academy of Arts and Sciences announces availability of grants-in-aid of research in chemistry or closely related fields. Applications for the grants of $300 or less, usually awarded for apparatus, supplies, or construction of special facilities needed in research, should be received by Frederick G. Keyes, Massachusetts Institute of Technology, Cambridge, Massachusetts, not later than April 15.

Fellowships

The Bermuda Biological Station for Research has received a grant of $6,000 from the American Philosophical Society to be used for research fellowships at the Bermuda Station, 1947–49. Applications should be forwarded to Dugald E. S. Brown, director, Biological Station, St. George's, Bermuda.

During the next few years the scientific program of the Station will be centered around the physiology of marine organisms. To this end laboratories of physiology, biochemistry, and biophysics are being constructed and adequate facilities provided for the collection and maintenance of a wide variety of marine organisms. When reconstruction is completed, 17 laboratories will be available to investigators and several rooms for workers not requiring laboratory facilities. By June of this year there will be living accommodations for 24 workers.

Colleges and Universities

The University of Texas Department of Zoology announces appointment of the following staff members whose terms began last Septemb... Clarence P. Oliver, University of Min... sota, professor; W. Frank Blair, U... versity of Michigan, assistant profes... Lemuel A. Fraser, University of Wisc... sin, instructor; and John M. Cair... Washington University, St. Louis, ... structor. Michael J. D. White, Universi... of London, England, has been appoint... professor of zoology to begin Septemb... 1947.

Washington and Lee Universit... Lexington, Virginia, announces th... Marcellus Henry Stow has been appoint... professor of geology and Lucius ... Desha, professor of chemistry, und... the Thomas Ball Foundation profess... ships recently established. The Fou... dation was established through a g... of Mrs. Alfred I. du Pont, Wilmingto... Delaware, in connection with the U... versity's bicentennial program as ... memorial to her father, Capt. Thom... Ball.

Dr. Stow served as deputy direct... of the Mining Division, War Producti... Board, during a wartime leave of absen... and before returning to the Universi... this session was chief of the Mini... Branch of the Civilian Production A... ministration.

Dr. Desha was professor of bi... chemistry at the University of Tennes... College of Medicine before going ... Washington and Lee. He is current... acting dean of the latter University.

The University of Utrecht, Neth... lands, has announced the followi... changes in science professorships since t... liberation: new appointments—J. B. ... Hol, physical geography; J. F. Reit... pharmacy; D. van Dantzig, mathemati... J. W. M. Milatz, physics; G. J. ... Oordt, zoology; and S. W. Visser, meteo... ology; retired—N. Schoorl, pharma... K. Oestreich, physical geography; J. ... Barrau, mathematics; E. van Everding... meteorology; deceased—L. S. Ornste... physics; H. J. Jordan, animal phys... ology; W. C. de Graaff, pharmacy; L. ... R. Rutten, paleontology; and J. Wa... mathematics.

The Polytechnic Institute ... Brooklyn, New York, has announc... the 6th and 7th symposia in a series ... eight on "Recent Progress in the Field ... High Polymers," to be held in the studen... lounge of the Institute, 99 Livingst... Street, Brooklyn.

"Advances in Physical and Organic emistry of Cellulose" will be discussed arch 29 by the following: Eugene su, Princeton University; H. J. ilipp, Celanese Corporation of America, d E. W. Roseveare, E. I. du Pont de mours & Company.

"Mechanism of Polymerization" will discussed April 19 by W. H. Melville, iversity of Aberdeen, Scotland; W. B. ynolds, Philipps Petroleum Company; G. Evans, University of Leeds, Eng- d; G. Goldfinger, University of Buf- o; and A. G. Evans, University of nchester, England.

Western Reserve University recently ceived a grant of $70,000 from the veland Foundation for continuation work on disease prevention and for search on infectious diseases by the isabeth Severance Prentiss Depart- nt of Preventive Medicine, founded 1945.

The Department is organizing and ipping a large laboratory for research influenza, common cold, pneumonia, d some common childhood diseases. e laboratory will occupy half of the rd floor of the School of Medicine ilding on the campus.

The Department is also working osely with the Cleveland Division of ealth and other health agencies, as ell as the staffs of university and city spitals, on a program of preventive edicine.

Last summer five members of the mmission on Acute Respiratory Dis- ses in the U. S. Army Epidemiological ard joined the Department, with John Dingle, director of the Commission, isabeth Severance professor of pre- ntive medicine. Work done by these n in the Army is being continued the University.

The University of Illinois has re- ntly acquired the parasitology library the late Henry Baldwin Ward. Some ,000 volumes have been purchased for 5,000, and the Ward family has given a Ward Memorial a reprint library of tween 35,000 and 40,000 items.

Meetings

The Pacific Division of AAAS will ld its 28th annual meeting in San Diego, lifornia, June 16–21, with headquarters the U. S. Grant Hotel.

The address of Thomas G. Thompson, esident of the Pacific Division, will be uesday evening, June 17, on the sub- ct, "Research." George L. Clarke, Harvard University, will discuss "Light and Life Within the Sea," June 18, and Lee A. DuBridge, president of the California Institute of Technology, "Radar and Its Peacetime Uses," June 19.

Excursions have been planned to Los Coronados Islands, Mt. Palomar, Borego Valley, and the Salton Sea.

General communications may be addressed to the chairman of the local general committee, R. Dana Russell, U. S. Navy Electronics Laboratory, San Diego. Correspondence about exhibits should be sent to Ormus L. Doolittle, Engineering Department, Southern California Telephone Company, San Diego 1.

The New York State Geological Association will hold its 19th field meeting at the College of the City of New York, May 9–10, 1947, year of the C.C.N.Y. centennial celebration. Reservations may be made through Cecil H. Kindle, Department of Geology, City College, New York 31.

Ten Swedish astronomers and geodesists will go to South America and five or six to Africa to study the solar eclipse on May 20. By means of exact timing of the eclipse an accurate determination of the distance between the two continents will be attempted, the Swedish-International Press Bureau states. The African group will probably be stationed north of the town of Accra on the Gold Coast, and the South American group at the Brazilian town of Araxá.

Astronomers from the United States, Brazil, Argentina, England, and New Zealand will observe the eclipse from Brazil and Argentina (*Science*, February 28).

Parcels have been sent to over 1,000 families of needy European scientists through the activities of a Committee of U. S. Scientists' Wives during the past year (*Science*, May 10, 1946). Packages have been sent to 400–500 Dutch, 210 Czech, 75 Polish, 100 Belgian, and 50 Greek families, as well as others in Finland, France, Norway, and Italy, the Committee reports. Many Poles, Czechs, Greeks, and others still need shoes, warm clothing, and foods, however. Names of needy families may be obtained from Grace H. Smith, National Bureau of Standards, Washington 25, D. C.

The Committee of Scientists' Wives has transmitted an appeal for Greek scientists by W. Edwards Deming, Bureau of the Budget, who recently returned from Athens. He pointed out that civil service assistants at the Laboratory of Astronomy and National Observatory in Athens, as well as the astronomical station at Pentele, under the direction of S. Plakidis, are paid about $30 a month by the Goverment. Explaining how far this goes, Dr. Deming said a luncheon costs more than $1, shirts no less than $8, shoes from $20 to $50, and sugar about $.35 a pound. The government appropriation for instruments, books, periodicals, and other equipment for the entire Department of Astronomy amounts to $350.

Prof. Plakidis, far from having modern equipment, has not even sufficient photographs of modern equipment to demonstrate in his lectures to about 30 students. Suggestions for donations are food and clothing; books and reprints; subscriptions to astronomical and mathematical journals; paper, pencils, pens, even scratch paper; any obsolete adding or computing machine; a slide rule; and the following equipment: a spectrohelioscope (Hale's type), a spectroheliograph, an astrographic refractor (15–20 inch), and a Schmidt camera (36 inch).

Parcels sent by mail are still limited to 11 pounds, and since recipients of parcel post packages of any size in Greece pay a tax of 6,000 drachmas, the equivalent of a day's wages, it is important to send up to the 11-pound limit. Dr. Deming also suggested a group shipment by freight to Prof. Plakidis, who would distribute the materials.

Inquiries and communications about Prof. Plakidis and other scientists in Greece should also be sent to the secretary of the Committee, Grace H. Smith, at the above address.

NRC News

The Division of Engineering and Industrial Research held its annual meeting March 3. Reviews of the major current activities of the Division were presented by the chairmen or the directors of the respective boards and committees.

Frederick M. Feiker, School of Engineering, George Washington University, outlined the proposed plan of organization, objectives, and probable methods of operation of the Building Research Advisory Board, which is being established at the request of the Construction Industry Advisory Council of the U. S. Chamber of Commerce to inventory and correlate technological research on building methods and materials. It is not

planned as a board to direct research or to establish or finance research projects.

The work of the Highway Research Board was reviewed by its director, Roy Crum. Now in its 26th year, the Board keeps in close touch with highway research, current and proposed, in every state of the Union. It disseminates highway research information obtained from these surveys by field representatives and other sources in a series of publications entitled "Research Correlation Circulars" and "Highway Research Abstracts." R. L. Morrison, University of Michigan, is chairman of the Board.

The Committee on Quartermaster Problems serves as an advisory group to the Office of the Quartermaster General in the latter's research and development program. Subcommittees have specific responsibilities in the fields of (1) plastics, (2) leather and footwear, (3) textiles, (4) germicides, insecticides, and biologicals, and (5) environmental protection. L. W. Bass, research director, Air Reduction Company, is chairman of this Committee, and W. George Parks is director.

The renewed activity of the Conference on Electrical Insulation was reported by the chairman, Ward F. Davidson, director of research, Consolidated Edison Company. This Conference, established some 20 years ago, held at the Johns Hopkins University last November the best-attended annual meeting in its history. The Conference each year publishes an annual report, including abstracts of papers given at its annual meeting. It also publishes annually a pamphlet now entitled "Digest of Contributions to Insulation Research."

The Committee on Artificial Limbs and the Committee on Sensory Devices are joint committees of the Division of Medical Sciences and the Division of Engineering and Industrial Research of the NRC. Both are advising on research and directing research in their respective fields for the Veterans Administration and the War Department. F. S. Strong, Jr., executive director, Committee on Artificial Limbs, reported for the chairman, Paul Klopsteg, director, Technological Institute, Northwestern University. The CAL program is attempting to develop more useful artificial members for veteran amputees and for the still greater number of civilians. Studies of available artificial limbs have been made, and the Committee participated in a survey of developments in artificial limbs in Great Britain and Germany and other Continental countries. Special attention has been given to control and operation of artificial hands by means of the muscles remaining in the arm stump. Other principal problems have been utilization of a suction socket for attachment of an artificial leg and development of some method of locking an artificial leg to bear weight when in a partially bent position.

The chairman of the Committee on Sensory Devices, George W. Corner, Department of Embryology, Carnegie Institution of Washington, told of studies made by his Committee in attempting to develop compact, hand-held, lightweight guidance devices for the blind. Such devices may be based on reflection of light or of supersonic waves. Attention has also been given to a device intended to read audibly, for the blind. This is actuated by a stylus drawn along the printed line of an ordinary type-wet book page. Magnifying projectors and special reading glasses intended for the aid of partially sighted subjects have also been studied.

The Committee on Ship Construction is advisory to the Bureau of Ships of the Navy Department in a research program on ship hull construction. Through the Bureau of Ships the Committee works very closely with the Ship Structure Committee, joint committee of the Navy, Coast Guard, the Maritime Commission, and American Bureau of Shipping. The problems of this program include testing of large welded and unwelded structures; correlation of such large-scale testing with laboratory tests; metallurgical factors affecting fabricating and service of hull steels; failure of typical ship structures under cyclic loading. The report was presented by Finn Jonassen, research coordinator for the Committee. The chairman is V. H. Schnee, assistant director, Battelle Memorial Institute.

Recent Deaths

Karl G. Berggren, 55, vice-president of Thomas A. Edison, Inc., and manager of the special production department, died in West Orange, New Jersey, February 13. A native of Sweden, he joined the Edison Corporation in 1927.

C. B. Waldron, 81, until recently professor of landscape gardening and forestry, North Dakota Agricultural College, Fargo, died March 6 in Fort Lauderdale, Florida.

August Frauehan, 45, assistant professor of chemistry, Miami University, Oxford, Ohio, died March 18 after an illness of several months.

Robert Newstead, 87, archeologist and entomologist, died recently at his home in Chester, England. Last year Prof. Newstead had presented his collection of scale insects, including 2,72[illegible] microscopic flies and 260 type specimens to the Natural History Department of the British Museum.

James E. King, 71, emeritus professor of gynecology at the University of Buffalo and a past-president of the International College of Surgeons, died March 9 in Buffalo, New York.

Frederico Nitti, 41, chief of the chemical and bacteriological service of the Pasteur Institute, died March 2 in Rome, Italy.

L. D. Huntoon, 78, former professor of mining and metallurgy at Yale University, died February 23 in Pleasantville, New York.

B. A. Linden, 53, bacteriologist with the Food and Drug Administration since its formation in 1927, died March 9 in Washington, D. C.

Make Plans for—

American Association of Anatomists, annual meeting, April 3–5, Mount Royal Hotel, Montreal, Canada.

American Mosquito Control Association, general meeting, April 5, Hotel Bellevue-Stratford, Philadelphia, Pennsylvania.

The Electrochemical Society, Inc., annual congress, April 9–12, Louisville, Kentucky.

American Chemical Society, spring meeting, April 14–18, Atlantic City, New Jersey.

Institute of Mathematical Statistics, meeting on stochastic processes and noise, April 24–25, New York City.

National Academy of Sciences, annual meeting, April 28–30, Academy Building, Washington, D. C.

American Medical Association, centennial session, June 9–13, Atlantic City, New Jersey.

COMMENTS
by Readers

The conference of representatives of about a hundred American scientific societies in Washington on February 23 brought about a hopeful renewal of action toward the establishment of a National Science Foundation. However, let no one be deceived into thinking that the goal is actually within reach. The 80th Congress still needs to be convinced of the necessity to the public welfare of a measure which will contribute to its difficulties in making its promised economies and tax relief. It is extremely unlikely that a National Science Foundation Act will be passed by this Congress without very strong pressures from aroused voters "back home."

There is little doubt now that the great majority of American scientists will pull together for the enactment of the best bill that the Inter-Society Committee can get Congressional leaders to accept. There is much doubt that the American public is sufficiently aware of the implications of the problem to be able or willing to exert the necessary influence upon the Congress to get action.

It seems unnecessary to explain further to scientists why a National Science Foundation is needed. The present problem is that of getting the lay public interested, informed, and active. This is an assignment that calls for a quality and quantity of civic responsibility on the part of scientists which they have rarely been willing to assume. Certain small numbers of scientists have always accepted their responsibilities as citizens, especially well informed in certain areas of public importance, but there has been and still is prevalent among scientists a feeling of repugnance against dirtying their hands by exposure to public, and therefore political, problems. The consequence has been that most scientists are silent on public problems, even those directly affecting and affected by science.

American scientists must realize that forces of circumstance beyond their control have thrust them into the maelstrom of modern politics. It is useless to complain that it is unfortunate, because it is a *fait accompli*. Our government, and every other government in proportion to its means, is already pouring hundreds of millions of dollars annually into science laboratories, and has thus already, in plain words, taken them over to a very large degree. The question today is no longer one of whether scientists want government subsidy and control, but simply one of what kind of governmental subsidy and control they will get.

To sit back and be silent while the future of American democratic society is at stake is escapism of a very low order indeed. As a group of citizens, scientists have in general no more rights, privileges, or duties than any other group. But each group in society has its special duty to the Nation as a whole to educate other citizens about those aspects of its own field that concern the general interest. Frequently in American political life we have been treated to the spectacle of special interest groups conniving for their own self-betterment. It would, of course, be a tragedy if American scientists were to follow such a pattern. But the need for a National Science Foundation is not primarily related to the welfare of scientists or even of science. Only a public need can justify the creation of it. Scientists generally agree that an urgent public need exists. As citizens, they have, therefore, a special obligation to educate their nonscientist fellow citizens concerning the basic facts of the problem.

A National Science Foundation serving the interests of the people is unlikely to be set up unless scientists do recognize that fact and begin now in an organized way to inform the American voter. Modern science sets standards of living and wins or loses modern wars, and the advancement and control of it may well be the deciding factor in keeping the peace. Scientists as citizens can, therefore, without much doubt determine the fate of the western democratic world by their action or inaction in the days ahead. (MAURICE B. VISSCHER, *University of Minnesota.*)

Dr. Pilcher's reply (*Science*, February 7, p. 160) to my earlier comment on the establishment of an organized program for cancer research presents a number of admirable arguments for a *coordinated* program on a national scale. I do not believe that my note (*Science*, November 22) contained any matter which was opposed to such an idea. My opposition—and that only on a very mild scale—was to a rigidly *directed* program, rather than to a well-organized one. I believe that the distinction between these approaches is quite clear. Whereas the former is apt to be held down to a certain degree in respect to versatility, the second type of approach is something to be highly desired. Certainly, such a program should be pushed through by all means available.

In the matter of penicillin development, Dr. Pilcher very aptly points out that 11 years were lost between the discovery and the beginning of real work on the problem. I wonder how much of that was due to the fact that even as late as 1929 the real implications of possibilities of scientific research were not at all clear to those who controlled the purse strings? It is unquestionably true that unless the funds are forthcoming, such work is apt to stagnate. The impact of the A-bomb surely served a very loud notice on the world in this respect. (G. M. KOSOLAPOFF, *Monsanto Chemical Company, Dayton, Ohio.*)

Although there are many reasons for attending scientific meetings, the major one for most scientists remains that of hearing original work described in person by those who performed the experiments. In this connection, and in view of my belief that one of the worst aspects of many papers is the use of lantern slides, may I suggest that (a) the only material put on the screen be that which is to be specifically referred to during the talk; (b) long columns of figures, while necessary in a published paper, be omitted from the slides; (c) slides be made with the smallest possible amount of material on each one, so that the observer is conscious of having absorbed their content before the next slide is shown; and (d) a typewritten sheet of paper subsequently photographed to make a slide usually renders the image too small and should be avoided. (G. H. BENHAM, *Illinois Institute of Technology, Chicago.*)

TECHNICAL PAPERS

Control of Cracking of Fruit by Rain

W. L. POWERS and W. B. BOLLEN

Oregon Agricultural Experiment Station, Corvallis

In submergence trials a very dilute solution of copper sulfate has given full control of cracking of cherries. Preliminary tests indicate that 0.1 per cent anhydrous copper sulfate can be included in the spray or dust for cherry fruit fly control to check cracking after rains. A pretreatment with 0.1 per cent lime hydrate checks cracking but is less effective than copper sulfate. Borax applied as a fertilizer at the rate of 1 pound/tree has reduced the cracking to one-third the amount observed on untreated adjacent areas. Similar beneficial results have been obtained with prunes.

of the value of this and other treatments for reducing cracking of cherries, prunes, carrots, beets, and tomatoes. It was supposed that borax might increase elasticity or toughness of the plant cell wall of fruit skin.

Cherry orchards in eight locations, all on humid soils, were used in cooperative field tests to determine the value of borax for decreasing the splitting of nearly ripe fruits after rains. The trials included several soil types, three varieties of cherries, and different rates and methods of application. Treatments were made early in February of 1942. Counts were usually made of 300 to 2,000 fruits/plot and by two or three persons to determine the percentage of cracked fruit at harvest time. Lack of fruit or damaging rain delayed these trials.

Data for 1942 and 1944 indicated some 25–50 per cent

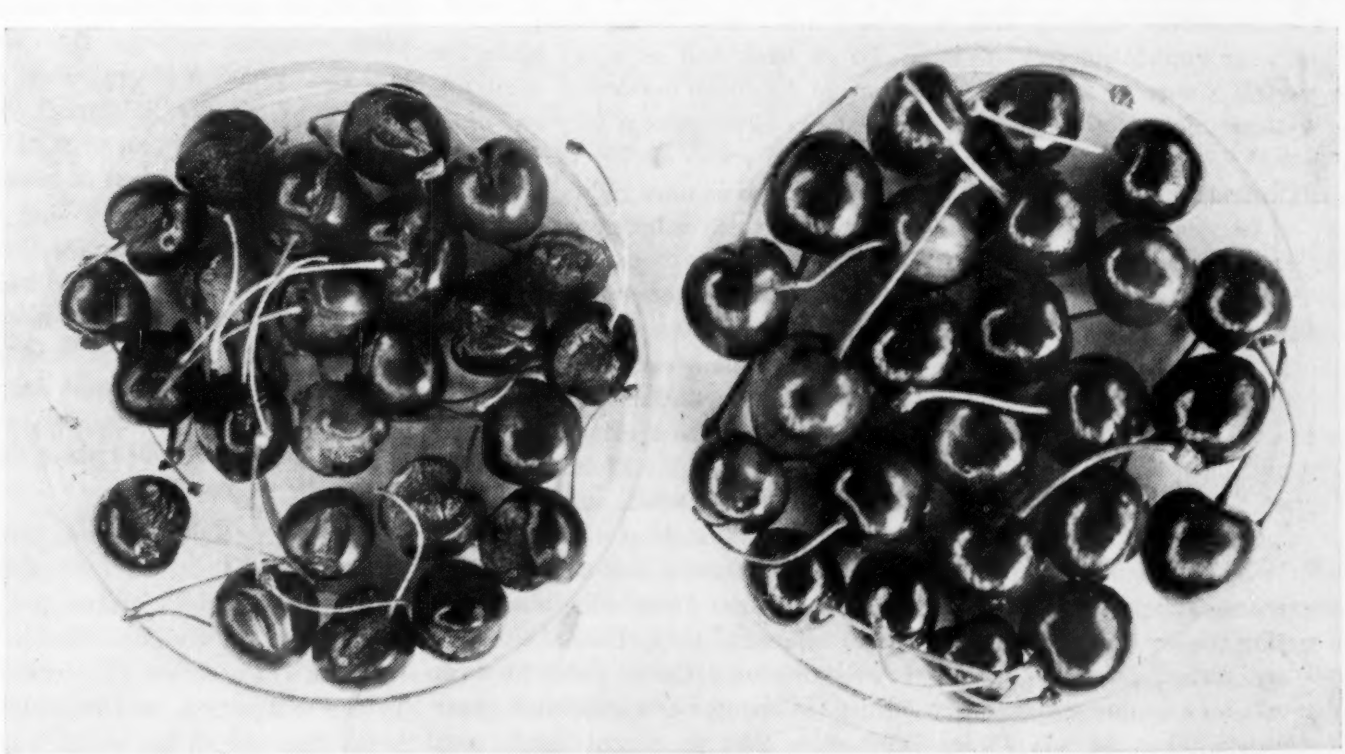

FIG. 1. Left: Bing cherries after 64 hours immersion in distilled water— 24 out of 25 cracked. Right: Bing cherries after immersion in .05 per cent copper sulfate—only 1 in 25 cracked.

Borax was freely applied for weed control under a back yard Bing cherry tree early in the spring of 1940, and the subsequent fruit crop was remarkably free from cracks.

Early rains the following September caused over half of the prune crop from trees in fertilizer test plots on Melbourne clay loam to fall to the ground. A count of 200 prunes still on trees of an untreated plot showed 25 per cent to be cracked. Where 30 pounds/acre of borax had been broadcast on the soil of an adjacent area, the cracking was reduced to 9 per cent.

Bing cherries on Amity silty clay loam and Salkum gravelly clay loam showed improved color of foliage and decreased cracking where borax had been applied. Available boron is low in the Salkum soil. These observations led to a study decrease in cracking where borax was applied. Two of the larger orchards with 24–30 trees/plot were re-treated, and observations in 1945 and 1946 showed one-half to one-third as much cracked fruit where borax had been applied. Chemical analyses of soil, leaf, and fruit samples revealed some definite increase in boron content of leaf and slight increase in fruit and available soil boron.

Growers noted improved color of foliage, and one of the cooperators made a commercial application to his whole orchard except for the test rows.

Immersion trials. When a rain of 1.6 inches failed to crack ripe and slightly withered prunes in September 1945, immersion tests were resorted to, using 25 fruits/test. Submergence in water caused all the fruits to crack in 48 hours. A

solution containing 0.25 per cent borax delayed and decreased cracking, with the result that some 50 per cent of the fruits were still sound after 48 hours.

Immersion trials were conducted with Bing cherries early in July 1946. In water, 80 per cent cracked in 16 hours and 100 per cent in 64 hours; with stems or only the leaves dipped in water, none cracked. Therefore, water absorption is through the skin. This caused gain in volume and weight. At the red stage of ripening, 100 per cent cracked in 16 hours. When fully ripe, 80 per cent of the nearly black fruits were cracked by immersion for 64 hours.

Solutions of 0.25–0.01 per cent anhydrous copper sulfate completely prevented cracking for four days, while those containing 0.25 per cent fructose, table sugar, sodium chloride, sodium oxalate, zinc sulfate, aerosol, or pretreatment with aerosol or calcium propionate, had little effect.

Pretreatment for 30 minutes with sulfur or calcium hydroxide, followed by immersion in water, decreased cracking somewhat. In two days immersion after the pretreatment with sulfur, 88 per cent were cracked. Pretreatment for 30 minutes with 0.1 per cent calcium hydrate reduced cracking to 16 per cent; that with 0.1 per cent copper sulfate, to 2 per cent. Continuous submergence of ripe Royal Ann cherries in the lime solution resulted in cracking of 16 per cent of the fruit in three days and 24 per cent in four days, while in the same strength of copper sulfate there were no cracked fruits at the end of four days.

Microorganisms in relation to cherry crack. Cracked cherries were removed from the solution after 24 hours; sound fruit and additional cherries developing cracks were withdrawn at 48 hours. Bacteria, yeasts, and molds were determined on 1 per cent dextrose agar. In the case of cracked fruit the cracks and adjacent skin were swabbed with a loop and streaked on poured plates. Sound fruit was rolled directly on the agar surface. In most cases the number of colonies was sufficiently restricted to permit counting, but with the Royal Anns confluent growth in many cases permitted only a rough estimate. Colony characteristics and confirmatory microscopic examination were used to differentiate spore formers (*Bacillus* sp.), micrococci, flavobacteria, and yeast. While the results are not rigidly quantitative, they present an index of the relative abundance of the various groups determined.

Numbers and kinds of microorganisms apparently are not related to cracking; flora of cracked fruit was found to be quantitatively and qualitatively similar to that of the sound cherries.

No molds developed on cracked fruit after removal from the solutions and maintenance at room temperature (25° C.) until shriveled (four or five days); neither was there any macroscopic development of bacteria or yeast.

After three to five days mold and bacterial growth appeared on all solutions except $CuSO_4$ above 0.01 per cent concentration. Bacteria but no molds developed on the 0.01 per cent $CuSO_4$ solution. Sound cherries left in the solutions after 48 hours remained sound at the close of the five-day observation period.

Trials with protective sprays. Pretreatment of very ripe Royal Ann cherries with 0.1 per cent copper sulfate spray and then repeated spraying caused only 1 per cent cracking in fruit; the water spray without pretreatment caused 6 per cent. Further copper tests with prunes and related pressure tests indicate bearing strength increased. It appears probable that 0.1 or 0.05 per cent anhydrous copper sulfate can be included in the cherry fruit fly spray or 3 per cent with the sulfur-containing dust for prunes and applied early in the morning.

Microscopic examination. Examination of skins of fruits after 48 hours submergence indicates that water increased turgidity of cells compared to that from lime, while plasmolysis was more in evidence after the copper treatment. In all cases there was a gain in weight during immersion.

Discussion and conclusion. Copper sulfate has given control of cracking of fruit in immersion tests, and preliminary spraying tests indicate that its use as a spray or dust will check cracking of fruit due to rains. The benefit reported from use of Bordeau spray (*3*) appears to be due more to the copper than the calcium contained. Bordeau reportedly increases transpiration (*1*) and may decrease fruit size.

How copper sulfate solution functions to prevent cracking of fruit is not fully determined. Cracking after rain has been related to osmotic concentration of the fruit juice, turgor of fruit, temperature, and skin permeability (*4*). Possibly the fruit cells are affected so less water is absorbed or held. The copper sulfate is effective at too low a concentration to have any appreciable osmotic effect. No specific fungi or other causative organism was found. It now appears more probable that the copper sulfate has a toughening effect (*2*) on the fruit skin comparable to that of tannin on leather.

It appears that the solution or spray, to be effective and noninjurious, should have a concentration of 0.1 to .01 per cent. Perhaps this material can be included in the cherry fruit fly spray or early morning dusting trials. Dilution of anhydrous copper sulfate with diatomite or other fine inert powder is suggested.

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Methionine Metabolism and A-Aminobutyric Acid

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A-amino-n-butyric acid has been identified by paper chromatography in the urine of a case of Fanconi syndrome (*1*).

It also occurs in appreciable amounts in normal blood and urine and has been found in a dilute acetic acid extract of yeast. It would appear to be very generally distributed in tissue nonprotein nitrogen.

On giving methionine (10 grams) by mouth, an increased output of α-aminobutyric acid and of methionine sulfoxide, as well as of methionine, can be detected in the urine, the overflow of all three following a similar course. This has been seen in a normal subject but was much more obvious in a case of Fanconi syndrome, in which "renal" aminoaciduria occurs.

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The conclusion is drawn that the methionine can be metabolized to α-aminobutyric acid and that it is probably the main source of the latter, since it does not, of course, occur in the protein of the diet. The fate of the carbon chain of the former now seems clear. A reinvestigation of the possible role of α-aminobutyric acid in the body is indicated. If its presence is essential, methionine may have to be wasted in order to produce it, and, in that case, giving it to animals on a low methionine diet may exert a methionine-sparing action.

Methionine sulfoxide may be of significance in oxidation-reduction potential. It can oxidize cysteine to cystine *in vitro* (*2*). Methionine, on standing under various conditions, readily changes largely into the sulfoxide and may therefore act as an oxygen carrier. In view of this easy oxidizability, however, its presence in the urine after methionine feeding needs more careful checking. It may have been formed by aerial oxidation. The validity of procedures for the determination of methionine in urine by oxidation reactions (H_2O_2, etc.) also arises.

Further details of these findings, which arose out of an investigation into the aminoaciduria in Fanconi syndrome, have been submitted to the *Biochemical Journal*.

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Failure to Produce Neoplasms in Rats by Feeding Heated Wheat-Germ Oil

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The announcement by Rowntree (*2*) in 1937 of the occurrence of neoplasms in Wistar rats following the ingestion of crude wheat-germ oil created considerable interest. The suggested relationship to diet as well as the production in experimental animals of malignant lesions of the gastrointestinal tract were factors of scientific importance. Attempts to duplicate these results were made in many laboratories, unfortunately without success (*1*). Since one of us (G. D.) had prepared some of the original wheat-germ oil used by Rowntree in his successful experiments, an attempt was made to duplicate his work, using oil prepared by the same operator and under the same laboratory conditions. Rowntree's diet was followed in detail, and Wistar rats were fed for almost a year. No neoplasms were produced (unreported work).

Some recent evidence has suggested that heated fats may contain carcinogenic factors possibly due to the conversion of sterols to carcinogens by heat (*3*). Wheat-germ oil is rich in sterols, and Rowntree, in the preparation of his diet, actually might have changed some of the sterols in the wheat-germ oil to carcinogens, since the oil was usually heated again before use to insure that no trace of ether smell remained.

In order to test this possibility, crude wheat-germ oil was prepared exactly as it had been previously. It was then heated at 275° C. for two hours. Three liters of heated oil were mixed with 10 kg. of basic diet in accordance with Rowntree's directions. Thirteen female Wistar rats with an average weight of 64 grams and 14 male Wistar rats with an average weight of 65.5 grams were started on the diet in November 1945. The animals grew somewhat slowly, compared to colony rats, but the growth rate was steady and the animals appeared healthy. There were a number of deaths due to colds and pneumonia. The surviving animals were killed and autopsied in July 1946. Seven males averaging 253 grams and 5 females averaging 213 grams survived. The condition of all animals was excellent, with no suggestion of any malignant lesions.

This evidence would seem to indicate that the sterols in wheat-germ oil are not converted to carcinogens by heat. The heat conversion of sterols to carcinogens was apparently not a factor in Rowntree's production of gastrointestinal lesions in the rat.

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The Occurrence of Two Fertile Florets in the Spikelets of *Chloris*

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During the writer's experience in seed analysis Rhodes grass (*Chloris Gayana* Kunth) was frequently received for purity analysis and for germination test. Early examination of spikelets of this species disclosed that many contained a fertile pedicellate floret in addition to the fertile basal and sessile floret. The presence of caryopses was the criterion employed.

Thus far no confirmation of this observation has been found in the available grass and general floras examined. The seed analyst is perhaps the person best situated to make such an observation, since each of his many routine analyses requires the examination of thousands of individual seeds or seed units, but his usually elementary knowledge of taxonomy might lead him to overlook the significance of such a fact.

Descriptions of the genus *Chloris*, as far as the writer has been able to determine, appear to be unanimously in agreement on the occurrence of one fertile floret in the spikelet, and this the basal, sessile floret. For example, Hitchcock (*1*) states: "Spikelets with 1 perfect floret, sessile, . . . the rachilla disarticulating above the glumes, produced beyond the perfect floret and bearing 1 to several reduced florets consisting of empty lemmas. . . ." In no instance was there more than one floret in the spikelet described as fertile in the literature available. Silveus' description (*3*) is worded identically, and those in other floras are either essentially similar or identical.

As the average purity, or seed set of *C. Gayana* by weight, was found to be approximately 25 per cent (37 lots) (*2*), it may be assumed that the number of pedicellate florets matur-

caryopses would likewise be a fraction of the total number perfect pedicellate florets. One count showed that one-rd of the florets of spikelets containing caryopses were dicellate. Another count yielded 25.2 per cent pedicellate rets with caryopses and represented a lot of more than 1,000 unds of commercial seed. Detailed examinations are being ntinued.

Other species of the genus containing such florets are the tive *C. latisquamea* Nash and *C. verticillata* Nutt., of the genus *Euchloris*. While no indication of perfect pedicellate rets has been found to date in *C. cucullata* Bisch., *C. ciliata* artz, *C. canterai* Arech., *C. divaricata* R. Br., and *C. virgata* artz, all indigenous to or naturalized in Texas, it is probable at insufficient material was examined. *C. verticillata*, a olific seeder and a very common species, contained 6 per nt of spikelets with mature or maturing caryopses in the dicellate spikelets, all of which also contained caryopses the basal florets.

In view of the above findings, it is proposed that the generic scription of *Chloris* should include wording somewhat as llows: "Spikelets 3- to 4-flowered, the florets reduced pro-ressively upward; perfect florets, 1 to 2; the first, basal d sessile; the second, pedicellate on the prolonged rachilla d perfect staminate, or neuter; the third staminate, or duced to lemma and palea or only the lemma; and the urth, when present, reduced to an empty lemma, or rep-sented only by the rachilla apex, the two uppermost florets rming a club-shaped rudiment."

Specimens of the three species found to have perfect pedicel-te florets have been submitted to Agnes Chase, agrostologist the Smithsonian Institution. The writer would appreciate rther confirmation of the facts presented and will be glad examine other species of *Chloris* for additional information.

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Translocation of a Radioactive Plant-Growth Regulator in Bean and Barley Plants

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Previous experiments have shown that the application of nonradioactive growth regulator (2,4-D) to a leaf or the roots a young bean plant causes a stimulus to be translocated to e stem, where it brings about an easily detected growth sponse (curvature). A study of this type of response has vealed that the translocation of such a growth-regulating imulus from a leaf to the stem is associated with the trans-cation of sugars along the same course and that it moves ainly in living cells (phloem); but when the stimulus is anslocated from the roots, it can apparently move within the stem in nonliving cells (xylem) (*3*). However, neither the amount of stimulus translocated and its entire course of movement throughout a plant nor the absorption and translocation of such a stimulus in grasses can be detected readily on the basis of curvature measurements.

The present investigation, in which a radioactive growth-regulating substance was used, was undertaken (a) to determine whether or not the radioactive component was absorbed and translocated by representative dicotyledonous and monocotyledonous plants, and (b) to measure the amount of the radioactive component translocated and accumulated in various parts of the treated plant.

Experimental Method

The compound, 2-iodo-3-nitrobenzoic acid (INBA), used in this study causes form changes in leaves of bean seedlings when a few micrograms are applied to one primary leaf of each seedling. The response to INBA was found to be similar in character to that elicited by 2,3,5-triiodobenzoic acid (*4*). Radioactive iodine^{131} was used as the tracer atom because of the relatively high energy of its beta radiation (0.67 Mev), its availability in experimental quantities,[1] its convenient half-life (8.0 days), and the ease with which it could be incorporated into INBA. Synthesis was accomplished by replacing the mercury by iodine in anhydro-2-hydroxymercuri-3-nitrobenzoic acid (*1*). With this method the synthesis can be completed in less than three hours, and no isomers or troublesome by-products are formed. The method has the disadvantage, however, that mercuric iodide, a by-product of the reaction, contains an appreciable fraction of the radioactive iodine used in the synthesis. This disadvantage can be minimized by employing an iodine solution of high specific activity or might be circumvented by using a synthesis involving the diazotization of 3-nitroanthranilic acid (*2*).

Radioactive INBA was synthesized on a submacroscale as follows: The reaction was conducted in a round-bottomed pyrex vessel of 15-ml. capacity having two necks fashioned from interchangeable ground-glass joints. A pyrex Liebig condenser was inserted in one outlet and a ground-glass stopper in the other. Stirring of the reaction mixture was accomplished by means of a small, hollow, sealed, glass capsule containing several lengths of soft iron wire, which was externally rotated by means of a motor-driven permanent magnet. An iodine solution was prepared by dissolving 200 mg. of potassium iodide in 7.5 ml. of radioactive iodine solution[2] and adding a solution of 230 mg. (1.39 mM) of potassium iodide and 360 mg. (1.42 mM) of stable iodine in 0.35 ml. of water. To a boiling solution of alkali (70 mg. of NaOH in 2.1 ml. of water) in the reaction flask was added portionwise, with stirring, 460 mg. (1.26 mM) of anhydro-2-hydroxymercuri-3-nitrobenzoic acid. Boiling and stirring were continued during the dropwise addition of 0.12 ml. of concentrated HCl. Heating was stopped and 0.04 ml. of glacial acetic acid was added. To this rapidly stirred mixture the iodine solution was added rapidly from a glass, 10-ml. hypodermic syringe equipped with a capillary

[1] Obtained through the Isotopes Branch, Manhattan District, Oak Ridge, Tennessee (*5*).

[2] Radioactive iodine was received on August 26, 1946, in the form of a N/10 sulfuric acid solution having a specific activity of 1 mc./ml.

delivery tube attached to the barrel. The reaction mixture was stirred and refluxed for 5 minutes and was then made alkaline (30 mg. NaOH), centrifuged, and the supernatant solution acidified to Congo red (ca. pH 4) by adding concentrated HCl. The precipitated INBA was collected by centrifugation and washed successively with a small volume of water and a solution of 0.1 gram potassium iodide in 2 ml. of water. After centrifuging, the acid was dissolved in 2 ml. of hot 50 per cent ethanol centrifuged hot and cooled to crystallize. The acid was recrystallized, using the same procedure, to yield 206 mg. of product (49 per cent of theory based on the 3-nitrophthalic acid used in preparing the anhydro-2-hydroxymercuri-3-nitrobenzoic acid) melting at 204.5–207.5° C. (cor.)—reported melting point (*1*), 204–205.5° C. Analysis calculated for $C_7H_4INO_4$: C, 28.69; H, 1.37; I, 43.31; N, 4.78; neutral equivalent, 293. Found: C, 28.83, 28.69; H, 1.84; 1.75; I, 44.13, 43.99; N, 4.27, 4.28; neutral equivalent, 295.5, 297.1.

Two series of reference standards for the radioactivity measurements, one of bean leaf tissue and one of bean petiole tissue, were prepared by adding known amounts of radioactive INBA to known amounts of the dried, ground (20 mesh) plant material. The acid was in the form of a dilute aqueous solution prepared by dilution of an alcoholic solution of the acid. At least 10 ml. of the aqueous solution was added for each gram of dried plant material to insure adequate distribution of the acid. The watery suspension of plant material which resulted was thoroughly mixed in a ball mill, dried (80° C.), and reground to 20 mesh in a Wiley mill. Standards of both leaf and petiole tissue were prepared to contain 1 part of the radioactive acid in 5000, 1 in 10,000, 1 in 100,000, and 1 in 1,000,000 parts of tissue.

For tracing the movement of radioactivity through bean

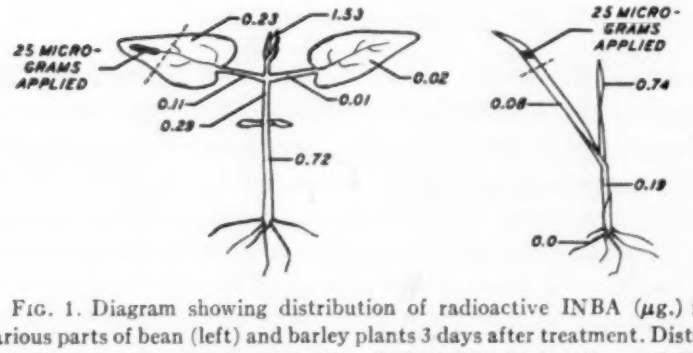

FIG. 1. Diagram showing distribution of radioactive INBA (μg.) in various parts of bean (left) and barley plants 3 days after treatment. Distal ends of treated leaves were severed as indicated by broken line and discarded prior to sectioning of plants.

(*Phaseolus vulgaris*) and barley (*Hordeum vulgare*) seedlings, the radioactive INBA was applied to a leaf of these plants as a paste made by first dissolving 25 mg. of the acid in 1 gram of melted polyethylene glycol (Carbowax 1500), followed by thorough mixing with 4 grams of melted lanolin. In treating leaves, 5-mg. aliquots of the paste (25 μg. of INBA) were applied to the upper surface and along the midrib of one primary leaf of each bean plant and as a band about 0.5 cm. wide across the upper surface and near the tip of the first true leaves of barley seedlings (Fig. 1). The bean plants used had well-developed primary leaves, but the trifoliate leaves were still folded tightly in the terminal buds at the time the plants were treated. The barley seedlings had one well-developed true leaf and a second leaf rapidly expanding at the time the plants were treated.

Three days after treatment the plants were carefully divided into parts, and the corresponding parts were combined, dried (forced draft oven at 80° C.), and ground (20 mesh) in a Wiley mill. One hundred mg. of each sample was spread uniformly over the surface of a shallow plastic cup, 3.5 cm. in diameter, and the radioactivity of each was measured by means of an Edelmann electrometer-ionization chamber.[3] Measurements of the radioactivity of the tissue standards and unknown samples were made in the same manner on the same day. Background measurements (natural radioactivity) were made at intervals during each series of measurements.

RESULTS AND CONCLUSIONS

The marked inhibitory action of INBA on the growth of the dicotyledonous bean plant and its slight action on the monocotyledonous barley plant are illustrated in Table 1.

TABLE 1

EFFECT OF RADIOACTIVE INBA ON GROWTH OF PARTS OF BEAN AND BARLEY PLANTS

Part	Untreated* control (mg./plant)	Treated* (mg./plant)	Wt. reduction (%)
Bean			
Primary leaf	218	193	11.5
Bud	15	9†	40.0
First internode	33	28‡	15.2
Hypocotyl	94	78†	17.0
Total above-ground portion	360	308‡	14.4
Barley			
First leaf	130	116	10.8
Second leaf	120	112	6.7
Stem§	122	110	9.8
Total plant	372	338	9.1

* Figures represent average fresh weight per plant 3 days after treatment, based on pooled samples of corresponding parts of 15 bean and 12 barley plants.

† Difference between corresponding parts from treated and untreated plants highly significant.

‡ Difference between corresponding parts from treated and untreated plants significant

§ Includes the stem and the section of leaves that sheathes the growing point.

In the bean plant the compound is most effective in inhibiting development of the bud. It should be pointed out that there is no apparent difference in the growth responses resulting from application of stable INBA and of radioactive INBA when equal amounts of the two compounds are applied separately to the leaves of bean seedlings.

The measurements given in Table 2 indicate that the compound was apparently absorbed by the leaves of bean

[3] The authors wish to express their appreciation to Dean Cowie, P. H. Abelson, and Charles Ksanda, Department of Terrestrial Magnetism, Carnegie Institution, for permitting them to use an electrometer and for guidance and assistance during these investigations.

seedlings and that it was translocated from treated leaves to the stems of the plants, where it accumulated mainly in the terminal buds and in the hypocotyls (Fig. 1). Greatest reduction in growth was observed in those parts of bean plants which became most highly radioactive as a result of the treatment.

Radioactive INBA was also apparently absorbed by the leaves of barley plants and accumulated mainly in the second leaf, which developed rapidly during the period of treatment (Table 3, Fig. 1).[4] In contrast to the results obtained with the bean plants, the presence of radioactive INBA in barley plants was not associated with a statistically significant decrease in their rate of growth. Since INBA appears to be absorbed by both bean and barley plants in these experiments, it must be inferred that the growth-inhibiting effects of INBA in the bean plant and its failure to produce significant inhibition in the barley plant must be due to differences either in INBA concentrations in the two plant types or in the manner in which INBA reacts with the plant constituents in each case.

The appearance of radioactivity in the plants following treatment with radioactive INBA does not prove, of course, that the intact INBA molecule actually entered the plant and was translocated as such. In subsequent experiments it has been shown, however, that the application of elemental iodine, 3-nitrobenzoic acid, or 3-nitrosalicylic acid fails to bring about responses in the bean plant similar to those resulting from application of INBA. Although these data do not constitute conclusive proof, it appears, in the case of the bean plants at least, that INBA enters the plants in molecular form and is translocated as such.

TABLE 2

RESULTS OF RADIOACTIVITY MEASUREMENTS ON PARTS OF BEAN PLANTS AFTER TREATMENT WITH RADIOACTIVE INBA

Plant part	Fresh wt. 46 plant parts (mg.)	Dry wt. 46 plant parts (mg.)	Net activity*	INBA/100 mg. dry plant part (γ)	INBA/single plant part† (γ)	INBA/unit net activity (γ)
Terminal bud	4,610	544	2.23	12.9	1.53	
Treated leaf section	34,700	3,820	0.048	0.277	0.230	
" petiole	7,940	526	0.162	0.935	0.107	
Untreated leaf	46,200	5,080	0.003	0.017	0.019	
" petiole	8,180	554	0.018	0.014	0.001	
First internode	17,400	1,274	0.184	1.06	0.294	
Hypocotyl	32,400	2,876	0.200	1.15	0.719	
Leaf standard: 1/10,000			1.59	10.0		6.29
Petiole standard: 1/10,000			1.82	10.0		5.49
			1.67	10.0		5.99
Leaf standard: 1/100,000			0.114	1.00		8.77‡
Petiole standard: 1/100,000			0.188	1.00		5.32
Leaf standard: 1/1,000,000§						
Petiole standard: 1/1,000,000§						
Average						5.77

* Corrected for background.

† Calculated from the relationship, $\frac{a \times b/100}{46}$, where a = dry weight (mg.) of 46 plant parts and b = INBA (γ)/100 mg. of plant part.

‡ Not included in average.

§ Radioactivity too weak to detect.

TABLE 3

RESULTS OF RADIOACTIVITY MEASUREMENTS ON PARTS OF BARLEY PLANTS AFTER TREATMENT WITH RADIOACTIVE INBA

Plant part	Fresh wt. 37 plant parts (mg.)	Dry wt. 37 plant parts (mg.)	Net activity*	INBA/100 mg. dry plant part (γ)	INBA/single plant part† (γ)	INBA/unit net activity (γ)
Treated first leaf	3,600	275	0.139	1.08	0.080	
Second leaf	3,440	384	0.919	7.16	0.743	
Stem and sheath	3,290	220	0.419	3.26	0.194	
Root	8,800	750	Nil			
Untreated whole barley			Nil			
Leaf standard: 1/5,000‡			2.42	20.0		8.26
Petiole standard: 1/5,000‡			2.76	20.0		7.25
Leaf standard: 1/5,000‡			2.38	20.0		8.40
Petiole standard: 1/5,000‡			2.63	20.0		7.60
Leaf standard: 1/10,000‡			1.04	10.0		9.62§
Petiole standard: 1/10,000‡			1.34	10.0		7.46
Average						7.79

* Corrected for background.

† Calculated from the relationship, $\frac{a \times b/100}{37}$, where a = dry weight (mg.) of 37 plant parts and b = INBA (γ)/100 mg. of plant part.

‡ These standards were prepared from parts of the bean plants and are the same ones reported in Table 2. A comparative analysis made at a later date between unit net activities of the bean plant standards and whole barley plant standards of the same concentration failed to show a difference greater than the 10–15 per cent which exists between duplicate analyses.

§ Not included in average.

[4] The fact that no radioactivity could be detected in the large, composite barley root sample means only that an insignificant portion of the applied INBA is present in the roots three days after application. This does not preclude the possibility, however, that a relatively high concentration of INBA might have been found in the actively growing root tips if it had been feasible to sample and measure the radioactivity of this extremely small fraction of the plant. No measurements were made on the roots of treated bean plants.

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IN THE LABORATORY

Inactivation of 2,4-D by Adsorption on Charcoal[1]

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A method has been found which will inactivate some preparations of 2,4-D by adsorption on activated charcoal. This method is important because of its simplicity and its thoroughness of action. Substances and equipment which have been in contact with 2,4-D frequently carry small residues which are injurious to plants. Inhibition and injury of succulent plant tissues such as bean and tomato have been observed to be caused by dilutions as low as ½ ppm, and hence it has been almost impossible to clean adequately equipment which has been used to hold herbicidal preparations. Also, instances may occur where the separation of 2,4-D from other materials is desired.

Experiments have shown that a solution of the water-soluble powder (sodium salt of 2,4-D, as prepared by the Dow Chemical Company) containing 1,000 ppm of the active principle can be safely sprayed on all but very young bean plants after being mixed and shaken with 1 per cent activated charcoal (Norit A). Bean plants sprayed with this material shortly after emergence indicate by a very slight nastic response that the adsorption on the carbon is not complete. However, the amount of active substance not adsorbed is so small that it can be disregarded for all practical purposes. The addition of a larger percentage of charcoal results in complete inactivation.

A hand sprayer which had been used to apply 2,4-D solution at the excessive concentration of 10,000 ppm was freed from injurious traces by rinsing with a 1 per cent Norit A suspension for 2 minutes. Young bean plants were uninjured by applications of inert solutions made with this same hand sprayer immediately after rinsing as described.

TABLE 1

Quantitative Adsorption of 2,4-D on Norit A as Estimated by Response of 10-Day-Old Bean Plants

Concentration of 2,4-D (ppm)	Norit A in suspension (%)	Effect of application by	
		Drop method	Spraying
1,000	1	0	0
5,000	3	0	++
5,000	5	0	+
10,000	5	0	++
10,000	10	0	+

0 = no visible effect; + = very slight effect; ++ = slight effect.

Tests carried out to determine the degree of inactivation have given positive results, as shown in Table 1. These were made by the drop method developed by Mitchell and Hamner (*2*) as well as by spraying entire plants.

It should be emphasized that the carbon treatment inactivated the water-soluble powder. Tests indicate that certain oil preparations, though somewhat affected, are inactivated much less readily. Further tests are being conducted to establish the behavior of other types and grades of carbon preparations.

It appears that the findings here reported may offer an explanation for variable results with soil treatments of 2,4-D (*1*). It had been found that weed seeds were not as readily destroyed in certain muck soils as in sandy soils. Perhaps some muck soils adsorb 2,4-D in the same manner as does charcoal.

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[1] Journal Article No. 859 (n.s.) from the Michigan Agricultural Experiment Station.

Pilometric Measurements and the Rheological Properties of Hair

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In man, various clinical conditions involving the loss of hair are known. Successful therapy, both locally or systemically, to counteract the loss of hair must be based on controlled experimentation. This calls for a clinical test which permits careful measurement of the firmness with which a single hair is attached to the skin and the determination of certain rheological properties (*5*) of the hair, such as its yield value, elasticity, and tensile strength.

An instrument was devised for a study of the effect of a systemic treatment on the firmness of attachment of hair to the scalp in certain clinical conditions.[1] Since then, a second instrument with significant improvements, termed "pilometer," was developed in collaboration with the Friend Laboratories, New York City.

The first device was of simple construction and consisted of a small clamp, a hook, and a ball-bearing pulley fastened to a vertical stand. The clamp was designed to hold the hair and was fastened to a silk cord which went over the pulley. A light-weight tube (Lusteroid) of 100-cc. capacity was hung on the hook attached to the other end of the cord. Clamp, cord, and tube had a total weight of 8 grams. The tube served as a container for weights in grams or water.

[1] The author wishes to thank Dr. Frank Co Tui, of New York University, for suggesting the problem of devising such an instrument.

The improved device (Fig. 1) is based on the same principle but has a balance in place of the tube. It is also equipped to permit the measurement of the elasticity of a hair and the degree of deformity on stretching.

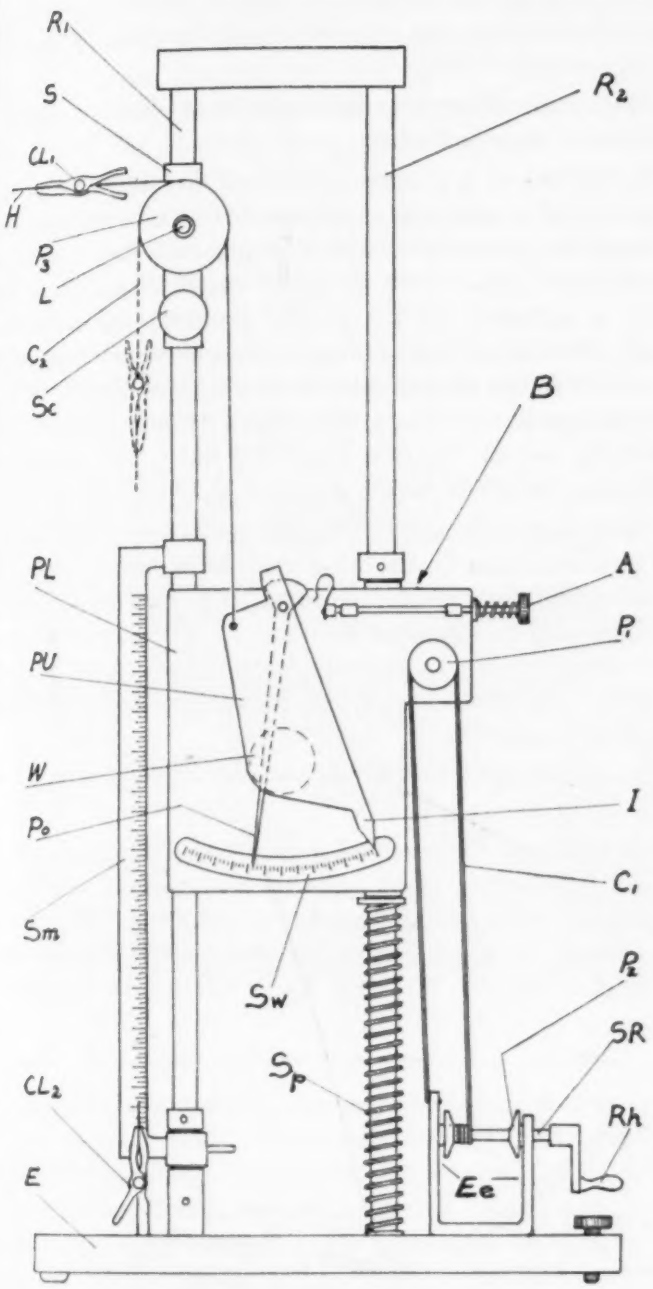

FIG. 1. Pilometer.

The balance, B, moves on two parallel, vertical rods, R_1, R_2, mounted on a base, E. A spring, Sp, to control the movement of the balance, is placed on rod R_2 between the base and the balance. The balance consists of the pendulum, PU, swinging on a plate, PL. The pendulum carries any given weight, at W, and has a projection which serves as the indicator, I. Two pulleys, P_1, P_2, are provided to lower the balance, one being fastened to the balance, and the other to an elevation, Ee, on the base. One end of a cord, C_1, is attached on the elevation, passes up and over pulley P_1, and returns to pulley P_2, which rotates on its axis, a small rod, SR. A third pulley, P_3, on ball bearings, L, is vertically movable on rod R_1 by means of slide S, which can be affixed by a head screw, Sc, to any desired height. The balance, B, is pulled slowly downward without vibrations by means of the rotating handle, Rh. One end of another cord, C_2, is attached to the pendulum of the balance and the other end to the clamp, CL_1, which holds the hair, H, while attached to the skin or after its detachment.

For measurements of properties of an isolated strand of hair, clamp CL_1 serves to hold one end, and clamp CL_2, at the base of the instrument, the other. A vertical scale, Sm, is used to measure the length of the strand of hair.

The instrument is operated as follows: A strand of hair still attached to the skin is clamped in CL_1, and the rotating handle is turned slowly until the hair becomes detached. The stress applied to the hair increases while the indicator moves along the scale, Sw, simultaneously with a pointer, Po, which is mounted behind the indicator and which remains at the maximum position after the hair becomes detached. Thereupon the indicator returns to zero. By pushing a button, A, the pointer can be brought back to zero.

The detached end of the hair is now put into clamp CL_2, and the rotating handle is again operated, but now for the purpose of measuring elasticity, yield value, and tensile strength.

For obtaining comparative values, hair was selected from an area located on the midline between the vertex and the linea nuchae. In a group of 42 healthy, white, male and female adults, the firmness of attachment ranged between 22 and 60 grams, averaging 34 grams; the tensile strength, between 65 and 120 grams, averaging 95 grams. Of interest are the findings in a small group of 4 male adult Chinese, the firmness of attachment being 64–88 grams, and the tensile strength 141–165 grams. These values definitely exceeded those obtained in the group of Whites. The individuals of the Chinese group may be exceptional, but the values obtained indicate the possibility of racial differences. The tensile strength measurements of Leftwich (*4*) were made with a comparatively crude method and gave an average of 7 ounces, or more than 200 grams. His subjects were presumably Whites.

It must be realized that the values should be amplified by a much larger number of observations in different male and female, racial and age groups on healthy subjects and on hair from various parts of the scalp as well as other regions of the body. In our experiments the tensile strength was measured immediately after the hair was pulled. Such tests should be made on several samples from the same area. It would also seem necessary to know how the hair has been treated prior to the tests. We found wide variations in comparing values obtained from different parts of the scalp or the body of the same individual.

The attachment of the hair to the skin may be supposed to be the firmness with which the cuticle of the hair is attached to the cuticle of the internal root sheath. Lower values of firmness of attachment or of "cuticle firmness" which occasionally are obtained upon several pullings may be due to progressive separation of the cuticles when the single hair is about to fall out. It is not yet known what brings about this process and what makes for firmness of hair attachment.

The pilometer permits clinical studies. Such investigations should be amplified and correlated with the analysis of X-ray diffraction patterns. Such patterns have been investigated recently by Astbury and his associates (*2*, *3*). Their studies of the elastic properties and molecular structure of unstretched and stretched hair resulted in a number of practical implications. Astbury (*1*) observed that if a hair is considerably stretched and steamed for several hours while stretched, the external scale sheath of the hair often breaks up into loose,

short, cylindrical sections. He points out that certain procedures to secure "permanent waves" are "inseparable from irreversible changes in the keratin molecule, changes that must be described, however reluctantly, as damage." We obtained from different subjects values of tensile strength which, in some cases, did not differ appreciably after several times of stretching, while in others the tensile strength decreased markedly.

Pilometric measurements may prove to be useful in testing both local and systemic treatments of any given substance in experimental subjects. The pilometer promises to be a tool by which the experimental biologist and dermatologist may test certain locally or systemically applied treatments for hair in health and disease.

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A New Method for the Direct Recording of Prolonged Time-dependent Processes[1]

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Loop and cathode-ray oscillographs at the present time have superseded all other methods of recording processes with temporal variations, although for some purposes they have certain deficiencies.

In medicine, for instance, it is regarded as a disadvantage that the process of photographic developing intervenes between recording and evaluation. Also, the standard recording scale requires excessive quantities of paper and film if a long record is to be made without changing the cassette. Thus, not only are there development difficulties, but analysis of the process as a whole is difficult. For these reasons some primitive, direct methods of recording (e.g. the soot kymograph) are still in use, although they do not meet present requirements as far as their frequency characteristics are concerned.

Medical research requires an efficient method of direct and continuous recording. A method of this type would serve essentially to correlate the experimental phenomena with the recording, to control the experiment according to the changes in the oscillogram, or to enable observation of certain functions (e.g. electrocardiogram) during an operation. It would also be useful for teaching and demonstration in schools. In many cases the greatest advantages of the loop and cathode-ray oscillographs, their frequency characteristics, are not exploited. In medicine, for example, while frequencies below 200–300 cycles often are recorded with the cathode-ray oscillograph, it is possible to develop devices for direct recording. It is of no importance that the recordings are not as large as usual. If the thickness of the record curves is sufficiently small compared with the maximum amplitude, the recording may easily be magnified suitably by projection on a screen. Moreover, a small recording has the advantage that a substantially longer period of registration is placed on the same amount of material. Generally speaking, this is the only method possible for making actual continuous study.

Such a method[2] has been developed on an electromechanical basis and is described below.

The cutting of a phonograph record may serve as an example in which maximum amplitudes of 0.08 are recorded. The resonant frequency of the phonograph recording system is about 5,000 cycles. Since an upper cutoff frequency of 500 cycles is sufficient for the present problem, the maximum amplitude required may be brought to the necessary magnitude by a small elastic force coupled to a lever transmission. For an electromagnetic recording system with a frequency range up to 500 cycles and an electrical input of 3 watts, this amplitude is 0.5 mm. (length of stroke, 1 mm.).

Such a magnitude may be seen directly, as may be, therefore, the total recording. On the other hand, for accurate evaluation of individual parts of the recording, they may be magnified optically to a maximum of 4–10 cm. by ordinary means and with normal space requirements. With suitable optics a much larger magnification is possible and may be used for lecturing and similar purposes.

The oscillographic method developed on this basis works as follows (Fig. 1):

The processes to be recorded (electrocardiogram, cerebral potential variations, blood pressure, etc.) are converted into electric quantities and conducted to an amplifier; this operates the recorder (S) which carries a stylus to cut the lacquer coat of the glass disc (G). While the disc is rotating, the recorder is

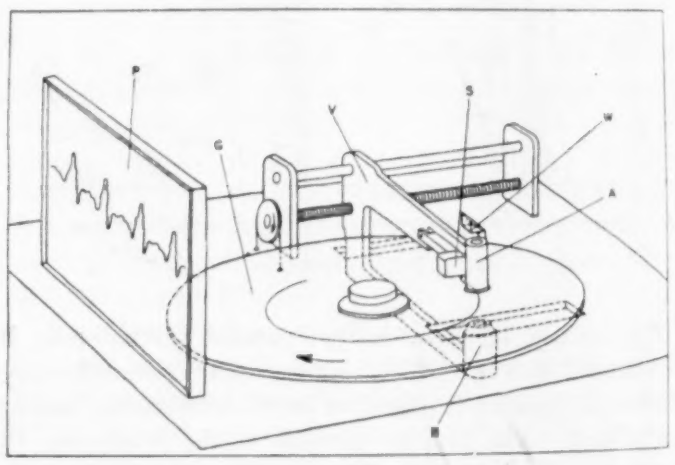

Fig. 1. Schematic representation of the recording method.

moved radially by foot gears (V); thus, as on phonograph records, the groove forms a spiral. An illuminating device (B, below disc), placed close to the stylus, is coupled to and moves with the recorder. The optical system (A, above disc) magnifies the process recorded by means of an angular mirror (W) and projects it onto a screen (P). At a moderate disc velocity (about 20–30 cm./second on the screen for electrocardiograms) it is easy to observe the process while it is being re-

[1] Technical Report No. 11 of the AAF Aero Medical Center, Helmholtz Institute, Branch Nussdorf/Inn, Germany, March 23, 1946.

[2] The measurements were carried out by A. Habermann.

corded and to reproject it later for exact evaluation or for copying.

The "pitch" of a spiral record whose maximum amplitude is 0.5 mm. is about 2 mm. If 5 cm. of a 30-cm. disc is used, there is an available recording length of 19 m. Compared with the usual electrocardiogram, the maximum amplitude of which is about 4 cm., this corresponds to 760 m. of film. An electrocardiogram may therefore be recorded continuously for 100 minutes without changing the disc.

When the angular velocity is kept constant, the spiral recording has the disadvantage that the time scale is different at different radial distances from the center of the disc. This can be compensated by a special timing device. Or, since the speed of rotation is low (0.25/minute for the electrocardiogram), a drive which will maintain a constant linear velocity just at the recorder can be designed relatively easily.

Fig. 2 shows a laboratory model of the apparatus. If required the zero line may be recorded at the same time by the

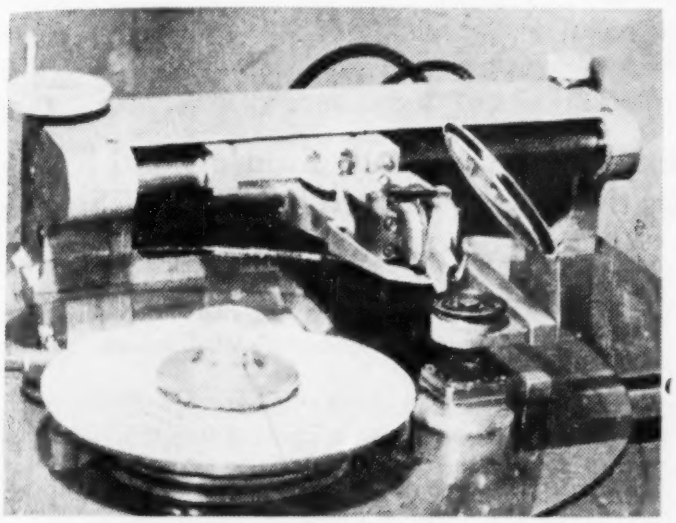

FIG. 2. Laboratory model of the recording device.

addition of a stationary stylus, or another process may be recorded simultaneously by a second recorder. The device is superior to photographic methods because the thickness of the lines is constant, whatever the recording velocity.

An electromagnetic phonograph system was first used as the recorder. It was adapted to the present purpose because of the experience gained while designing it. The stylus amplitude required was determined by varying the armature's elastic control force and by lever transmission. Optimal conditions (*i.e.* amplitude as great as possible at linear amplitude characteristics and the armature's resonant frequency as high as possible) are ensured by adapting the geometric shape of the vibrating system correctly to the magnetic forces available. By utilizing the magnetizing curve up to saturation (Saettigung), these were increased to the limit attainable. The recorder is arranged in such a way in relation to the disc that the armature's axis of rotation is not parallel to the disc's face (as in cutting phonograph records) but perpendicular to it. This is necessitated by the fact that the stylus' point describes a flat arc and otherwise would move off the glass surface.

The recorder is operated with constant current in order to obtain a straight frequency characteristic. This presumes that the inner resistance of the voltage supply is large compared with the resistance of the recorder. If operated from an amplifier tube, matching by a transformer is difficult due to the very low cutoff frequency required. The recorder, therefore, is connected directly to the anode circuit of a pentode (high inner resistance) and the direct-current anode is compensated. For the type described, the maximum amplitude requires a current of 20 Ma. At a frequency of 700 cycles, the impedance being 6,000 ohms, this corresponds to an alternating-current input of 2.5 watts.

Because of its electromagnetic system, the recorder has some hysteresis, and the recording of absolute quantities is subject to a certain error (about 5 per cent). Therefore, the development of an electrodynamic system was begun.

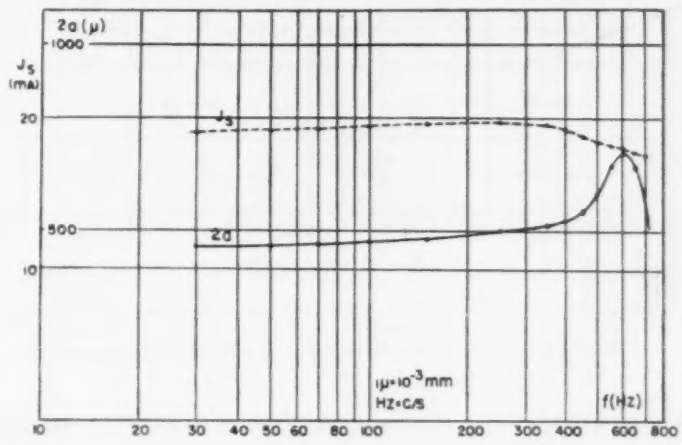

FIG. 3. Electromagnetic recorder: frequency characteristic of the current and of the recorded amplitude.

In Figs. 3, 4, and 5 the frequency and amplitude characteristics of the electromagnetic and electrodynamic systems are compared.

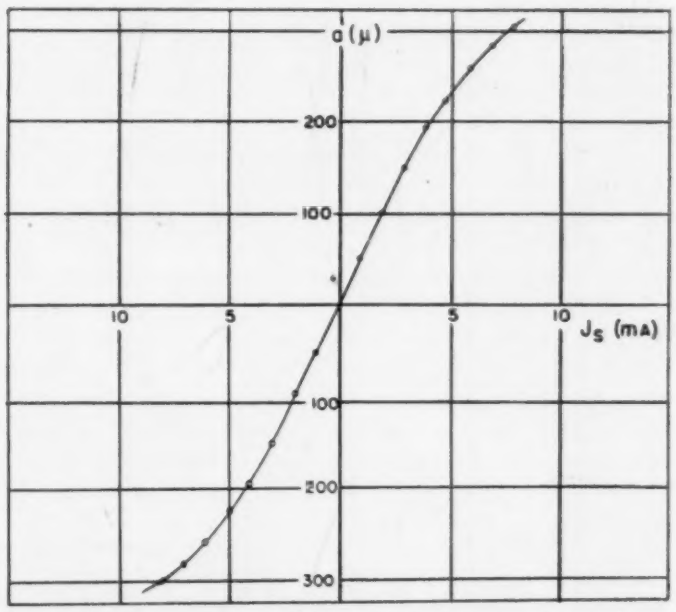

FIG. 4. Amplitude characteristic of the electromagnetic recorder.

Since the development of the electrodynamic recorder is not complete, its frequency characteristic cannot be given. It is probable that it will be linear and in the range from 0 to 250 cycles.

In order to obtain a sufficiently narrow groove, the point of the stylus should have a radius of curvature of about 0.01 mm. It must be resistant to abrasion but should not be so hard as to scratch the glass surface (tungsten). Since such a radius of curvature cannot be produced by a machine, the needle is made by a chemothermal process.

The first experiments were carried out with a disc of sooted glass. The resulting grooves had a thickness of 0.05 mm., despite the fact that the stylus used had very fine points,

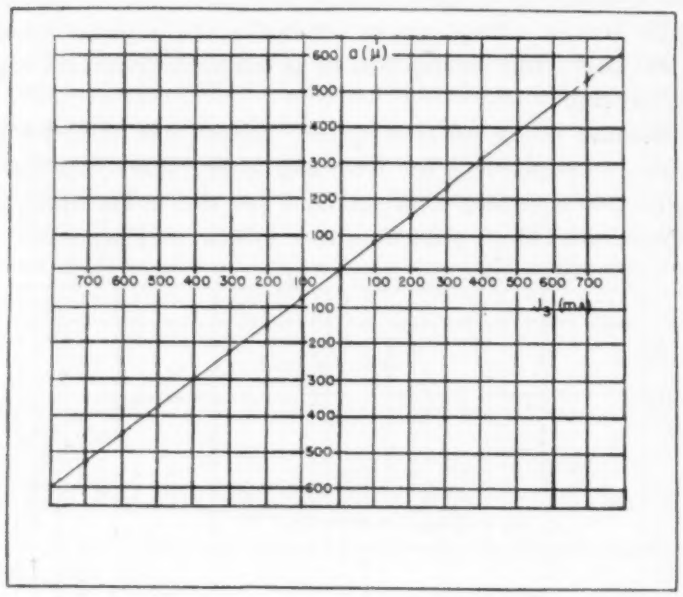

FIG. 5. Amplitude characteristic of the electrodyne recorder.

because the soot was removed in clinging flakes. The requirements which the coating must meet are: homogeneity (no crystal formation), pliability (minimal effect upon the ampli-

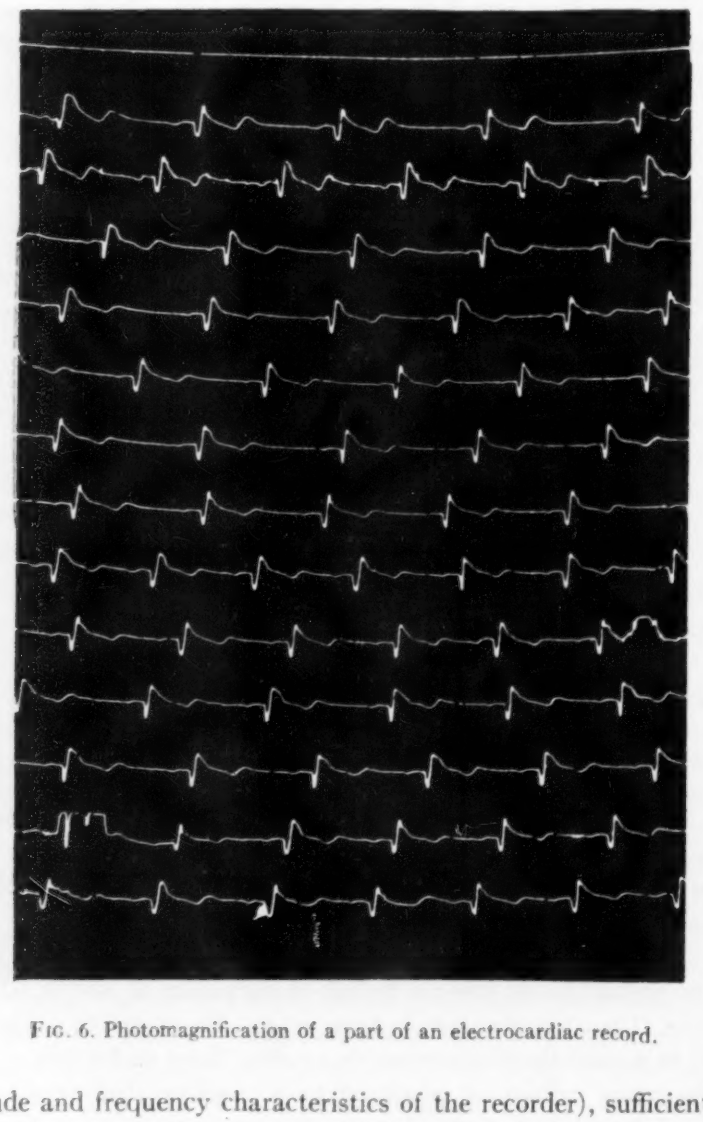

FIG. 6. Photomagnification of a part of an electrocardiac record.

tude and frequency characteristics of the recorder), sufficient opacity of very thin layers, and fine tracings during recording.

After several trials with pigmented albumin, gelatin, and paraffin coatings, a pigmented and desiccated solution of soap proved most appropriate. The tungsten point mentioned produces a groove 0.01 mm. thick in the soap. At an amplitude of 0.5 mm. the capacity of customary oscillographic methods is exceeded considerably. Not every soap is suitable for this purpose. The best results were accomplished with an American soap; the reason for this is now being investigated.

Discs of plate glass 30 cm. in diameter and 8 mm. thick were used as recording material. The disc should have an absolutely smooth surface, since even fine scratches damage the stylus. The manufacture of recording material is practicable and simple with the standard laboratory outfit. The cost is low, since the discs may be reused indefinitely.

Fig. 6 shows an electrocardiogram obtained with the method described above. The disc rotated constantly at 0.25 r.p.m. so that points on two adjacent grooves lying on the same radius represent events occurring 4 minutes apart.

This new electromechanical method of oscillography, although developed primarily for medical use, may, of course, be applied to other fields. Technical details of its development will be given in a later report.

Experimental Production of Anti-Rh Sera by the Use of Human Erythrocyte Stromata

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It was shown by Landsteiner and Wiener (*3*) that erythrocytes of *Macacus rhesus*, when injected into rabbits or guinea pigs, will produce an antiserum which, after suitable absorption, reacts with 85 per cent of human Caucasian bloods but fails to react with 15 per cent. Later, Gallagher and Jones (*2*) produced anti-Rh sera of the same specificity by the injection of human Rh+ erythrocytes into guinea pigs. Also subsequently, Wiener and Belkin (*4*) demonstrated that the Rh agglutinogen resides in the stroma of the erythrocyte and that it is of a haptene nature.

It had been shown earlier by Witebsky and Heide (*5*) that the injection of rabbits with boiled stromata of type N human erythrocytes produced sera having a high titer of N antibodies and a low titer of species specific antibodies. Calvin, *et al.* (*1*) have shown that the Rh haptene is probably a lipoprotein and is heat labile. We have inoculated guinea pigs with freshly prepared stromata of Rh+ human erythrocytes and produced antisera which, when absorbed with Rh− red cells until they no longer reacted with the absorbing cells, gave reagents that distinguished between Rh+ and Rh− erythrocytes.

The stromata were prepared by lysing Rh+ red blood cells in distilled water. The suspensions were passed through a Sharples supercentrifuge and the lysate discarded. The stromata were repeatedly washed with distilled water and centrifuged until the wash water was free of hemoglobin. With the resulting pale pink, gelatinous residue guinea pigs were immunized by repeated intraperitoneal inoculation. One week or more following the last injection the pigs were bled and the sera separated. After inactivation at 56°C. for 30 minutes the sera were absorbed as indicated above

with Rh− erythrocytes. In this way two antistromata testing sera were prepared.

TABLE 1

COMPARATIVE SPECIFICITIES OF Rh TESTING SERA

Commercial anti-Rh_o	Antirhesus guinea pig	Antistroma guinea pig No. 516	Antistroma guinea pig Sg	No. of cell specimens
+	+	+	+	79
−	−	−	−	20
+	−	−	−	2
−	+	−	−	2
+	−	−	+	2
+	+	+	−	1
+	−	+	+	1
+	+	−	+	1
+	+	−	−	1
Total				109

The specificities of these sera were determined by testing them against 109 blood specimens chosen at random. For comparative purposes simultaneous tests were also performed with commercial anti-Rh_o serum (Blood Transfusion Betterment Association, New York City) and guinea pig antirhesus serum. The results of these tests are summarized in Table 1.

It is apparent that the stromata of Rh+ human red blood cells can serve as a suitable antigen for the production of Rh testing sera in experimental animals. With the particular stromata used in our experiments sera approximating the specificity of human anti-Rh_o serum were produced. The few divergent results noted in the data may be ascribed to the well-known differences in avidity of some red cells for antibodies in the sera or to inherent reactive characteristics of guinea pig serum.

Some of our other experiments, which are not sufficiently developed to report at this time, suggest that Rh subtype sera may be produced experimentally by careful selection of the cells used for immunization and absorption.

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Book Reviews

Principles of radar. (2nd ed.) Members of the Staff, Radar School, Massachusetts Institute of Technology. New York–London: McGraw-Hill, 1946. 12 Chapters. (Illustrated.) $5.00.

This book was originally written for use as a reference text at the M.I.T. Radar School during the war. Although the second edition has been reworked and brought reasonably up to date, there remains some evidence of the high security classification of radar during the war years. This eliminates much of the most recent work on the subject. The book brings together in one place something of all the important wartime radar developments for the use of students and the numerous technical people who have been kept away from radar activity by other pursuits.

The radar art has grown in the last few years to such an extent that it is not possible in this one volume to cover completely all phases of the subject. For this reason the quantitative details which are necessary to an equipment design are missing, and the field of radar test equipment has been entirely excluded. However, a sufficient description of each technique is included to show its field of applicability.

Advantage is taken of the numerous specialists available to M.I.T. by having a large number of contributors, each in his own field. It is surprising that the tones of the various chapters, written by different authors, have been kept as similar as they have.

In a few instances the authors have made that mistake which is too common with technical writers—the procedure of giving the details of operation of a particular circuit or device without first having given both the purpose of the device and an outline of the fundamental concepts upon which its operation depends. The reader thus finds it necessary to read the exposition at least twice. However, on the whole, this kind of thing has been avoided, and the book has been kept reasonably easy to read. The action of multivibrators, for instance, has been well handled to avoid making this relatively simple device seem complicated.

The early chapters cover an "Introduction" to radar; "Timing Circuits," including ringing circuits, blocking oscillators, and pulse-forming networks; and cathode-ray "Indicators," with the many possible circuits for producing sweep voltages or currents. A chapter is devoted to wide-band "Receivers," their noise problems, and the automatic frequency-control systems necessary at the extremely high radio frequencies sometimes employed. Transmitters are covered by three chapters on "Magnetrons," "Triode Transmitters," and "Modulators." The changes required in these components to obtain short, high-power pulses in packages consistent with the low average power are significant. Separate chapters are provided on "Radio-Frequency Lines" and "Wave Guides and Cavity Resonators" in order to outline the many new techniques in these two fields. An especially long chapter on "Radar Antennas and Propagation" is needed to cover adequately the many forms which highly directive antennas may take. A chapter on "Transmit-Receive Devices" points out antenna-switching methods to permit the use of a single antenna alternately for transmitting and receiving. The text is concluded with a chapter on "Synchros and Servo-Mechanisms" to show, very briefly, how antenna position information may be delivered to suitable indicators and computers.

The book should serve very well in promoting a general knowledge of radar techniques and thus permitting these techniques to receive widespread application in a peacetime world.

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Lectures on the calculus of variations. Gilbert A. Bliss. Chicago: Univ. Chicago Press, 1946. Pp. ix + 296. $5.00.

This book, written by a mathematician who exerted a profound influence upon the modern development of calculus of variations, represents a most significant addition to textbook literature on the highest level. It contains both the fundamentals of the theory and a judicious selection of advanced results. In particular, it contains an integrated exposition of the many significant results that were obtained by the author and his pupils in the problem of Bolza over a period of years.

The book is divided into two parts. Part I, on the simpler problems of the calculus of variations, is concerned with problems in three-space of a relatively elementary character and is comprised of six chapters, as follows: "The Calculus of Variations in Three-Space"; "Sufficient Conditions for a Minimum"; "Fields and the Hamilton-Jacobi Theory"; "Problems in the Plane and in Higher Spaces"; "Problems in Parametric Form"; and "Problems With Variable End-Points." Part II, on the problem of Bolza, is subdivided into the following chapters: "The Multiplier Rule"; "Further Necessary Conditions for a Minimum"; and "Sufficient Conditions for a Minimum." The appendix which follows gives an excellent exposition of the existence theorems for implicit functions and for differential equations that are needed in the theory. The bibliography contains 77 titles, many of which represent the work of members of the Chicago school.

Even though moderate in size, the book contains a very complete account of the field covered. The exposition is uniformly excellent. The decision of the author to begin with a development of the theory in three-space is a wise one. The plane case is deceptively simple in many ways and, as a first study, is unsuited to prepare the reader for the phenomena that arise in the general case. The restriction to simple integral problems is justified, perhaps, for the opposite reason. Indeed, double integral problems present so many distressing features that the enthusiasm of the beginner may not survive the initial shock. Analogous remarks apply to various other topics that are not discussed in detail in the book. The so-called direct method, for example, involves an excessive amount of the general theory of functions of real variables, and the specific features that make calculus of variations such a fascinating study may become obscured thereby in a first introduction to the field. In view of the fact that the author contributed a beautiful study of several important special problems in an earlier volume (*Calculus of variations*, in the Carus monograph series), the lack of applications in the present volume is also justified, even though the reviewer had welcomed some further detailed studies of classical variation problems (for example, the isoperimetric problem on surfaces of constant curvature).

The reviewer feels that the book fills a very definite need in a very admirable manner. It is indispensable for those who wish to study or teach the subject.

T. RADÓ

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Scientific Book Register

ANDERSON, RUDOLPH MARTIN. *Catalogue of Canadian Recent mammals.* (Department of Mines and Resources, Mines and Geology Branch, National Museum of Canada, Bull. No. 102, Biological Ser. No. 31.) Ottawa: Edmond Cloutier, 1947. Pp. v + 238. $.75.

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